BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE

Environmental report for the draft maritime spatial plan for the German Exclusive Economic Zone in the North Sea

– unofficial translation –

2 June 2021

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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 in the North and Baltic Seas
AWI	Alfred Wegener Institute for Polar and Marine Research
AWZ	Exclusive economic zone
BBergG	Federal Mining Act
BfN	Federal Agency for Nature Conservation
BFO	Federal sectoral plan for offshore
BFO-N	Federal sectoral plan for offshore North Sea
BFO-O	Federal Sectoral Plan Offshore Baltic Sea
BGBl	Federal Law Gazette
BMUB	Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
BNatSchG	Nature Conservation and Landscape Management Act (Bundesnaturschutzgesetz)
BNetzA	Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railway
BSH	Federal Maritime and Hydrographic Agency
CMS	Convention on the Conservation of Migratory Species of Wild Animals
CTD	Conductivity, Temperature, Depth Sensor
DC	Direct Current
EMSON	Survey of marine mammals and seabirds in the German EEZ of the North Sea and Baltic Sea
EnWG	Electricity and Gas Supply Act (Energy Industry Act)
EUNIS	European Nature Information System
EUROBATS	Agreement on the conservation of European bat populations
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	Compatibility assessment according to Art. 6 para. 3 Habitats Directive or § 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	Leibniz Institute for Baltic Sea Research Warnemünde
IUCN	International Union for Conservation of Nature and Natural Resources (World Conservation Union)
K	Kelvin

LRT	Habitat type according to FFH Directive
MARPOL	International Convention for the Prevention of Pollution from Ships
MINOS	Marine warm-blooded animals in the North Sea and Baltic Sea: basics for the assessment of wind turbines in the offshore area
MRO	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 reserve
NN	Normal zero
OSPAR	Oslo-Paris Agreement
OWP	Offshore wind farm
PAH	Polycyclic aromatic hydrocarbons
POD	Porpoise Click Detector
PSU	Practical Salinity Units
ROP	Maritime spatial plan
ROP 2009	Maritime Spatial Plan for the German EEZ 2009
ROP	Draft Maritime Spatial Plan for the German EEZ 2021
SCANS	Small Cetacean Abundance in the North Sea and Adjacent Waters
SeeAnlV	Ordinance on Installations Seaward of the Boundary of the German Territorial Sea (Marine Installations Ordinance)
SEL	Sound event level
SPA	Special Protected Area
SPEC	Species of European Conservation Concern (Important Species for Bird Conservation in Europe)
StUK4	Standard "Investigation of impacts of offshore wind turbines".
StUKplus	"Accompanying ecological research on the alpha ventus offshore test field project".
SUP	Strategic environmental assessment
SUP-RL	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 (SEA Directive)
UBA	Federal Environment Agency
TSO	Transmission system operator
UVPG	Environmental Impact Assessment Act
MSRP	Environmental impact assessment
UVS	Environmental impact study
VARS	Visual Automatic Recording System
VMS	Vessel Monitoring System
V-RL	Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (Birds Directive)
WEA	Wind turbine
WindSeeG	Act on the Development and Promotion of Wind Energy at Sea (Wind Energy at Sea Act - WindSeeG)

1 Introduction

1.1 Legal basis and tasks of the environmental assessment

Maritime spatial planning in the German Exclusive Economic Zone (EEZ) is the responsibility of the federal government under the Spatial Planning Act (ROG)[1]. Pursuant to Sec. 17 (1) ROG, the competent Federal Ministry, the Federal Ministry of the Interior, for Building and the Home Affairs (BMI), draws up a spatial plan for the German EEZ as a statutory instrument in agreement with the federal ministries concerned. Pursuant to sec. 17 para. 1 sentence 3 of the ROG, the BSH, with the approval of the BMI, carries out the preparatory procedural steps for the preparation of the maritime spatial plan. During the preparation of the ROP, an environmental assessment is carried out in accordance with the provisions of the ROG and, where applicable, those of the Environmental Impact Assessment Act (UVPG)[2], the so-called Strategic Environmental Assessment (SEA).

The obligation to conduct a strategic environmental assessment, including the preparation of an environmental report, arises for the updating, amendment and repeal of the existing maritime spatial plans from 2009 from sec. 7 para. 7, 8 ROG in conjunction with sec. 35 para. 1 no. 1 ROG in conjunction with sec. 35 para. 1 no. 1 ROG. sec. 35 para. 1 No. 1 UVPG in conjunction with No. 1.6 of Annex 5. No. 1.6 of Annex 5.

According to Art. 1 of the 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 adequately taken into account in the preparation and adoption of plans well before the actual planning of the project. Pursuant to sec. 8 ROG, the Strategic Environmental Assessment has the task of identifying the likely significant effects of implementing the plan and describing and assessing them in an environmental report at an early stage. It serves to ensure effective environmental precaution in accordance with the applicable laws and is carried out according to uniform principles and with public participation. All objects of protection pursuant to sec. 8 para. 1 ROG are to be considered:

- people, including human health,
- animals, plants and biodiversity,
- land, soil, water, air, climate and landscape,
- Cultural assets and other material assets as well as
- the interactions between the aforementioned protected interests.

Within the framework of spatial planning, specifications are mainly made in the form of priority and reserved areas as well as other objectives and principles.

The requirements and content of the environmental report to be prepared are set out in Annex 1 to sec. 8 para. 1 ROG.

Accordingly, the environmental report consists of an introduction, a description and assessment of the environmental impacts identified in the environmental assessment pursuant to sec. 8 para. 1 ROG, and additional information.

According to No. 2d) of Annex 1 to sec. 8 ROG, other planning options that expressly come into consideration should also be named, taking into account the objectives and the spatial scope of the ROP.

[11] Of 22 December 2008 (Federal Law Gazette I p. 2986), last amended by Article 159 of the Ordinance of 19 June 2020 (Federal Law Gazette I p. 1328).

[2] In the version published on 24 February 2010, Federal Law Gazette I p. 94, last amended by Article 2 of the Act of 30 November 2016 (Federal Law Gazette I p. 2749).

1.2 Brief description of the content and the most important objectives of the maritime spatial plan

According to sec. 17 para. 1 ROG, the maritime spatial plan for the German EEZ shall, taking into account any interactions between land and sea and taking into account safety aspects, determine

1. to ensure the safety and and ease of navigation,
2. to further economic uses,
3. on scientific uses and
4. to protect and improve the the marine environment.

Pursuant to sec. 7 para. 1 of the ROG, maritime spatial plans must define **objectives and principles of** spatial planning for the development, organisation and protection of the area, in particular the uses and functions of the area, for a specific planning area and for a regular medium-term period.

Pursuant to sec. 7 para. 3 ROG, these designations may also designate areas. For the EEZ, these may be the following areas:

Priority areas designated for specific spatially significant functions or uses and excluding other spatially significant functions or uses in that area to the extent that they are incompatible with the priority functions or uses.

Reserved areas which are to be reserved for certain spatially significant functions or uses to which particular weight is to be attached when weighing them up against competing spatially significant functions or uses.

Marine suitability areas where certain spatially significant functions or uses do not conflict with other spatially significant concerns, where these functions or uses are excluded elsewhere in the planning area.

In the case of priority areas, it may be stipulated that they also have the effect of suitability areas pursuant to Article 7(3) sentence 2 no. 4 ROG.

Pursuant to sec. 7 para. 4 ROG, the maritime spatial plans shall also contain those specifications on spatially significant plans and measures by public bodies and persons under private law pursuant to sec. 4 para. 1 sentence 2 ROG which are suitable for inclusion in maritime spatial plans and necessary for the coordination of spatial claims and which can be secured by spatial development objectives or principles.

1.3 Relationship with other relevant plans, programmes and projects

In Germany, in order to coordinate all spatial demands and concerns arising in a space, there is a tiered planning system of spatial planning through federal spatial planning as well as state and regional planning, with which, according to sec. 1 para. 1 sentence 2 ROG,**{** XE "ROG" \t "*Raumordnungsgesetz*" **}** different demands on the space are coordinated with each other in order to balance out conflicts arising at the respective planning level and to make provisions for individual uses and functions of the space.

Through the tiered system, the plans are further specified by the subsequent planning levels. According to sec. 1 para. 3 ROG, the development, organisation and safeguarding of the sub-areas should fit into the conditions and requirements of the overall area, and the development, organisation and safeguarding of the overall area should take into account the conditions and requirements of its sub-areas.

The Federal Ministry of the Interior, for Building and the Interior (BMI**{** XE "BMI" \t "*Bundesministerium des Inneren, für Bau und Heimat*" **}**) is responsible for spatial planning at federal level in the EEZ. On the other hand, the respective federal state is responsible for regional planning for the entire area of the country, including the respective territorial sea.

In addition to spatial planning for the respective areas of responsibility, sectoral plans exist on the basis of sectoral laws for certain specific planning areas. Sectoral plans serve to define details for the respective sector, taking into account the requirements of spatial planning.

1.3.1 Maritime spatial plans in adjacent areas

In the interests of coherent planning, coordination processes with the plans of the coastal federal states and neighbouring states are indicated and must be taken into account in the cumulative assessment of impacts on the marine environment. Currently, the regional spatial planning for both Lower Saxony and Schleswig-Holstein is in the process of being updated. Regional spatial planning programmes of the coastal regions are taken into account insofar as significant specifications for the coastal sea are made.

1.3.1.1 Lower Saxony

The spatial development plan for the state of Lower Saxony, including the Lower Saxony - coastal sea, constitutes the State Spatial Development Programme (LROP**{** XE "LROP" \t "*Landes-Raumordnungsprogramm Niedersachsen*" **}**). The Lower Saxony Ministry of Food, Agriculture and Consumer Protection, as the highest state planning authority, is responsible for its preparation and amendment; the final decision on the LROP is the responsibility of the state government. The LROP is based on an ordinance from 1994 and has been updated several times since then, most recently in 2017. The procedure for a new update was initiated at the end of 2019.

1.3.1.2 Schleswig-Holstein

In Schleswig-Holstein, the Land Development Plan (LEP S-H **{** XE "LEP S-H" \t "*Landesentwicklungsplan Schleswig-Holstein*" **}**) is the basis for the spatial development of the Land. The Ministry of the Interior, Rural Areas, Integration and Equality of Schleswig-Holstein (MILIG) is responsible for its preparation and amendment. The current LEP S-H 2010 is the basis for the spatial development of the Land until 2025. The Land of Schleswig-Holstein has initiated the procedure for an update of the LEP S-H 2010 and conducted a participation procedure in 2019.

1.3.1.3 Netherlands

The Netherlands is in the fourth revision cycle, currently in the preparation of the planning phase. The plan is binding and covers one planning area.

1.3.1.4 United Kingdom

England consists of eleven planning areas and each area is to have its own plan. These are to be designed for the long term of approximately 20 years and updated every three years. It is envisaged that all plans will be in place by 2021.

The Scottish Plan is currently being revised and is in its second cycle. Consultation on the revision of the first plan has now closed. Scotland has a national marine spatial plan and eleven regional planning areas. The spatial plans are also binding there.

1.3.1.5 Denmark

Denmark is at an advanced stage of the spatial planning process. Denmark is currently drafting the first overall spatial plan for the North Sea and the Baltic Sea, which will be binding and cover a timeframe until 2050.

1.3.2 MSFD Programme of Measures

Each Member State must develop a marine strategy to achieve good status for its marine waters, in Germany for the North Sea and the Baltic Sea. Essential to this is the establishment of a programme of measures to achieve or maintain good environmental status and the practical implementation of this programme of measures. The establishment of the programme of measures (BMUB, 2016) is regulated in Germany by section 45h of the Federal Water Act (WHG). Under Objective 2.4 "Seas with sustainably and sparingly used resources", the current MSFD Programme of

Measures lists maritime spatial planning as a contribution of existing measures to achieving the operational objectives of the MSFD. The catalogue of measures also formulates a concrete review mandate for the updating of maritime spatial plans with regard to measures for the protection of migratory species in the marine area. Both the environmental objectives of the MSFD and the MSFD programme of measures are taken into account in the SEA.

1.3.3 Management plans for the North Sea EEZ nature conservation areas

On 17 November 2017, the Federal Agency for Nature Conservation (BfN) initiated the participation procedure pursuant to Sec. 7 para. 3 Ordinance on the Establishment of the Nature Conservation Area "Borkum Riffgrund" (NSGBRgV) [3], Sec. 7 para. 3 Ordinance on the Establishment of the Nature Conservation Area "Doggerbank (NSGDgbV) [4]and Sec. 9 para. 3 Ordinance on the Establishment of the Nature Conservation Area "Sylter Außenriff- Östliche Deutsche Bucht" (NSGSylV)[5] on the management plans for the nature conservation areas in the German EEZ of the North Sea were initiated. On 13 May 2020, the management plans "Borkum Riffgrund"[6], "Doggerbank" [7]and "Sylter Außenriff - Östliche Deutsche Bucht"[8] were published in the Federal Gazette.

1.3.4 Staged planning procedure for offshore wind energy and power lines (central model)

For the area of the German EEZ, a multi-stage planning and approval process - i.e. a subdivision into several stages - is envisaged for some uses, such as offshore wind energy and power cables. In this context, the instrument of maritime spatial planning is at the highest and superordinate level. The maritime spatial plan is the forward-looking planning instrument that coordinates a wide variety of utilisation interests in the fields of business, science and research as well as protection claims. A Strategic Environmental Assessment must be carried out when the maritime spatial plan is drawn up. The SEA for the ROP is related to various downstream environmental assessments, in particular the directly downstream SEA for the land development plan (FEP).

The next step is the FEP. Within the framework of the so-called central model, the FEP is the steering instrument for the orderly expansion of offshore wind energy and the electricity grids in a staged planning process. The FEP has the character of a sectoral plan. The sectoral plan is designed to plan the use of offshore wind energy and electricity grids in a targeted manner and as optimally as possible under the given framework conditions - in particular the requirements of spatial planning - by defining areas and sites as well as locations, routes and route corridors for grid connections and for cross-border submarine cable systems. The preparation, updating and amendment of the FEP is always accompanied by a strategic environmental assessment.

In the next step, the areas for offshore wind turbines identified in the FEP are pre-surveyed. The preliminary investigation is followed by a determination of the suitability of the area for the construction and operation of offshore wind turbines if the requirements of sec. 12 para. 2 WindSeeG are met. The preliminary investigation is also accompanied by a strategic environmental assessment.

If the suitability of an area for the use of offshore wind energy is determined, the area is put out to tender and the winning bidder or the person entitled to do so can submit an application for approval (planning approval or planning permission) for the construction and operation

[3] Of 22 September 2017 (Federal Law Gazette I p. 3395).

[4]" of 22 September 2017 (Federal Law Gazette I p. 3400).

[5] Of 22 September 2017 (Federal Law Gazette I p. 3423).

[6] Published on 17 April 2020, BAnz AT 13.05.2020 B9.

[7] Published on 13 May 2020, BAnz AT 13.05.2020 B10.

[8] Published on 13 May 2020, BAnz AT 13.05.2020 B11.

of wind turbines on the area specified in the FEP. Within the framework of the planning approval procedure, an environmental impact assessment is carried out if the requirements are met.

While the areas defined in the FEP for the use of offshore wind energy are pre-surveyed and put out to tender, this is not the case for defined sites, routes and route corridors for grid connections or cross-border submarine cable systems. Upon application, a planning approval procedure including environmental assessment is usually carried out for the construction and operation of grid connection lines. The same applies to cross-border submarine cable systems.

Pursuant to Article 1(4) UVPG, the UVPG also applies where federal or Land legislation does not specify the environmental impact assessment in more detail or does not observe the essential requirements of the UVPG.

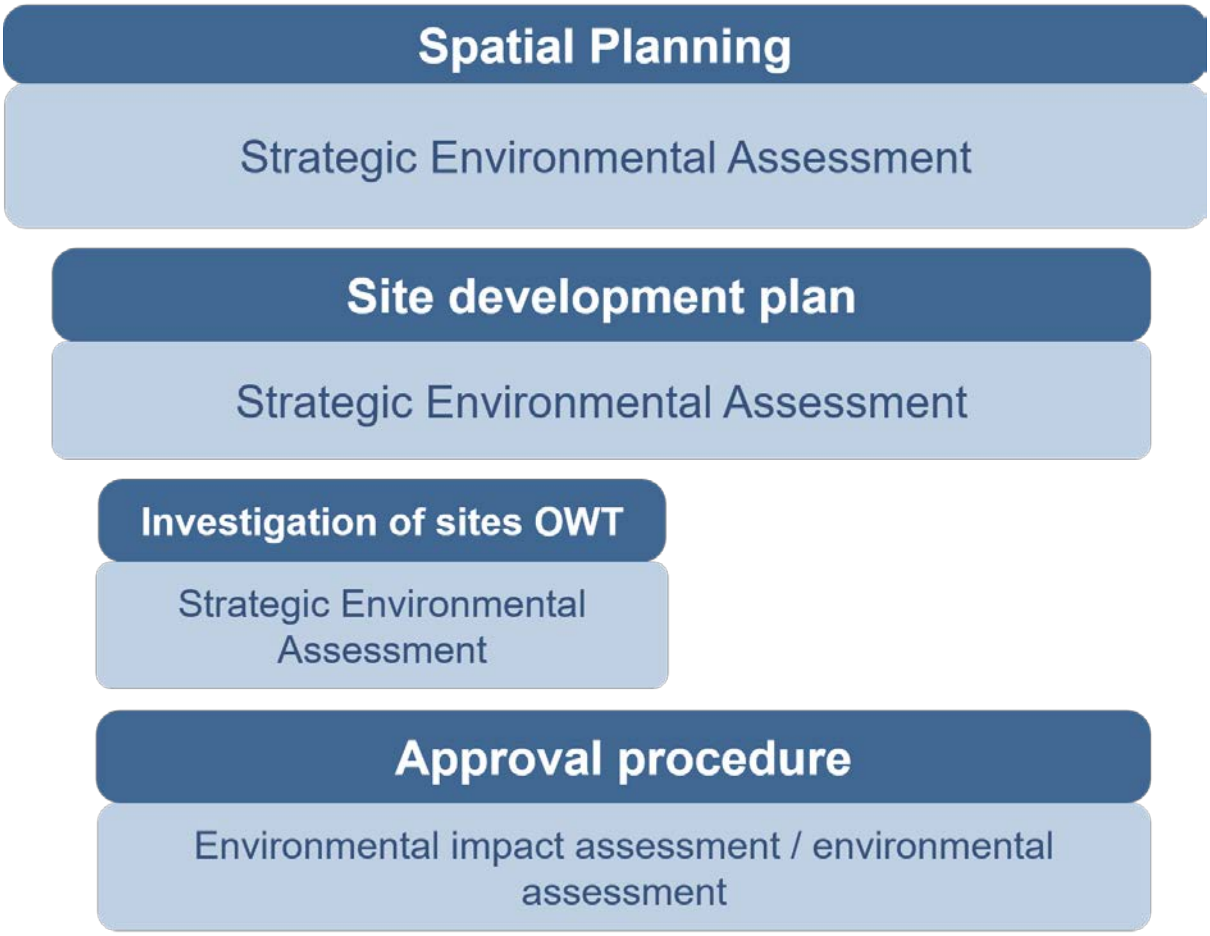


Figure 1: Overview of the staged planning and approval process in the EEZ.

In the case of multi-stage planning and approval processes, the respective sectoral legislation (e.g. Spatial Planning Act, WindSeeG and BBergG) or, more generally, Sec. 39 (3) of the Environmental Impact Assessment Act (UVPG) stipulates that, in the case of plans, it should be determined at the time of defining the scope of the assessment at which of the stages of the process certain environmental impacts are to be assessed. In this way, multiple assessments are to be avoided. The nature and extent of the environmental effects, technical requirements and the content and subject matter of the plan must be taken into account.

In the case of subsequent plans and in the case of subsequent approvals of projects for which the plan sets a framework, the environmental assessment pursuant to Sec. 39 (3) sentence 3 UVPG shall be limited to additional or other significant environmental effects and to necessary updates and deepening.

Within the framework of the staged planning and approval process, all assessments have in common that environmental impacts on the protected interests specified in Article 8 (1) ROG or Article 2 (1) UVGP, including their interactions, are considered.

According to the definition in Article 2 (2) UVPG, environmental effects within the meaning of the UVPG are direct and indirect effects of a project or the implementation of a plan or programme on the objects of protection.

According to sec. 3 UVPG, environmental assessments comprise the identification, description and evaluation of the significant effects of a project or a plan or programme on the objects of protection. 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 area, the special conservation areas of avifauna: seabirds/resting birds and migratory birds, benthos, biotope types, plankton, marine mammals, fish and bats have established themselves as subcategories of the legally named conservation areas of animals, plants and biological diversity.

Figure 2: Overview of the objects of protection in the environmental assessments .

In detail, the staged planning process is as follows:

1.3.4.1 Maritime Spatial Planning (EEZ)

At the highest and superordinate level is the instrument of maritime spatial planning. For sustainable spatial development in the EEZ, the BSH prepares a spatial planning plan on behalf of the responsible federal ministry, which comes into force in the form of legal ordinances.

The maritime spatial plans shall, taking into account any interactions between land and sea as well as safety aspects, determine

- to ensure the safety and ease of shipping traffic,
- to other economic uses,
- on scientific uses and
- to protect and enhance the marine environment.

Within the framework of spatial planning, specifications are predominantly made in the form of priority and reserved areas as well as other objectives and principles. Pursuant to sec. 8 para. 1 ROG, a strategic environmental assessment must be carried out by the body responsible for the spatial plan when drawing up spatial plans, in which the likely significant effects of the respective spatial plan on the protected assets, including interactions, are to be identified, described and assessed.

The **aim of** the spatial planning instrument is to optimise overall planning solutions. A wider spectrum of uses and functions is considered. At the beginning of a planning process, strategic fundamental questions are to be clarified. Thus the instrument functions primarily and within the framework of the legal provisions as a steering planning instrument of the planning administrative bodies in order to create a spatially and as far as possible environmentally compatible framework for all uses.

The **depth of assessment in** spatial planning is fundamentally characterised by a greater breadth of investigation, i.e. a fundamentally greater number of planning options, and a lesser depth of investigation in the sense of detailed analyses. Above all, regional, national and global impacts as well as secondary, cumulative and synergetic impacts are taken into account.

The **focus is** therefore on possible cumulative effects, strategic and large-scale planning options and possible transboundary impacts.

1.3.4.2 Land development plan

At the next level is the FEP.

The **specifications** to be made by the FEP and to be examined within the framework of the SEA are derived from sec. 5 para. 1 WindSeeG. The plan mainly specifies areas and sites for wind turbines and the expected capacity to be installed on the sites. In addition, the FEP specifies routes, route corridors and locations. Furthermore, planning and technical principles are laid down. Although these also serve to reduce environmental impacts, they can also lead to impacts, so that an assessment is required as part of the SEA.

With regard to the **objectives of** the FEP, it deals with the fundamental questions of the use of offshore wind energy and grid connections on the basis of the legal requirements, especially with regard to the need, purpose, technology and the identification of sites and routes or route corridors. The plan therefore primarily has the function of a steering planning instrument to create a spatially and as far as possible environmentally compatible framework for the realisation 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 greater breadth of investigation, i.e. a greater number of alternatives and, in principle, a lesser depth of investigation. As a rule, no detailed analyses are carried out at the level of sectoral planning. Above all, local, national and global impacts as well as secondary, cumulative and synergetic impacts are taken into account in the sense of an overall assessment.

As with the instrument of maritime spatial planning, the **focus of the** assessment is on possible cumulative effects and possible cross-border impacts. In addition, the strategic, technical and spatial alternatives for the use of wind energy and power lines are a focus of the FEP.

1.3.4.3 Suitability test within the scope

of the preliminary investigation

The next step in the staged planning process is the suitability assessment of areas for offshore wind turbines.

In addition, the power to be installed on the area in question is determined.

Pursuant to sec. 10 para. 2 of the WindSeeG, the suitability test shall examine whether the construction and operation of offshore wind energy turbines on the site do not conflict with the criteria for the inadmissibility of the designation of a site in the site development plan pursuant to sec. 5 para. 3 of the WindSeeG or, insofar as they can be assessed independently of the subsequent design of the project, with the concerns relevant to the planning approval pursuant to sec. 48 para. 4 sentence 1 of the WindSeeG.

Both the criteria of sec. 5 para. 3 WindSeeG and the concerns of sec. 48 para. 4 sentence 1 WindSeeG require an assessment of whether the marine environment is endangered. With regard to the latter concerns, it must be checked in particular whether pollution of the marine environment within the meaning of Article 1(1)(4) of the United Nations Convention on the Law of the Sea is not to be feared and bird migration is not endangered.

The preliminary investigation with the suitability test or determination is thus the instrument between the FEP and the individual approval procedure for offshore wind turbines. It relates to a specific area designated in the FEP and is therefore much more detailed than the FEP. It is distinguished from the planning approval procedure by the fact that a test approach is to be applied that is independent of the subsequent concrete turbine type and layout. The impact forecast is based on model parameters, for example in two scenarios or ranges, which are intended to represent possible realistic developments.

Compared to the FEP, the SEA of the suitability assessment is thus characterised by a smaller investigation area and a greater **depth of investigation.** In principle, fewer and spatially limited alternatives are seriously considered. The two primary alternatives are the determination of the suitability of an area on the one hand and the determination of its (possibly also partial) unsuitability (see sec. 12 para. 6 WindSeeG) on the other. Restrictions on the type and extent of development, which are included in the determination of suitability, are not alternatives in this sense.

The **focus of** the environmental assessment in the context of the suitability assessment is on the consideration of the local impacts caused by a development with wind turbines in relation to the site and the location of the development on the site.

1.3.4.4 Approval procedures (planning approval and planning permission procedures) for offshore wind turbines

The next stage after the preliminary investigation is the approval procedure for the construction and operation of offshore wind turbines. After the pre-investigation area has been put out to tender by the BNetzA, the winning bidder can submit an application for planning approval or - if the requirements are met - for planning permission for the construction and operation of offshore wind turbines, including the necessary ancillary facilities, on the pre-investigated area to the BNetzA in accordance with sec. 46 para. 1 of the WindSeeG.

In addition to the legal requirements of sec. 73 para. 1 sentence 2 VwVfG, the plan must include the information contained in sec. 47 para. 1 WindSeeG. The plan may only be adopted under certain conditions listed in sec. 48 para. 4 of the WindSeeG and, inter alia, only if the marine environment is not endangered, in particular if there is no concern of pollution of the marine environment within the meaning of Article 1 (1) No. 4 of the Convention on the Law of the Sea and bird migration is not endangered.

Pursuant to sec. 24 UVPG, the competent authority shall prepare a summary presentation

- the environmental impact of the project,
- the characteristics of the project and the site that are intended to exclude, mitigate or compensate for significant adverse environmental effects,
- the measures to exclude, reduce or compensate for significant adverse environmental effects, and
- of compensatory measures in the case of interventions in nature and landscape.

Pursuant to Article 16 (1) UVPG, the developer shall submit a report to the competent authority on the likely environmental effects of the project (EIA report), which shall contain at least the following information:

- A description of the project including the location, nature, scope and design, size and other essential characteristics of the project,
- a description of the environment and its components in the area of impact of the project,
- a description of the characteristics of the project and the site which are intended to exclude, reduce or compensate for the occurrence of significant adverse environmental effects of the project,
- a description of the planned measures to exclude, reduce or compensate for the occurrence of significant adverse environmental effects of the project and a description of planned compensatory measures,
- a description of the expected significant environmental effects 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 an indication of the main reasons for the choice made, taking into account the environmental effects of each; and
- a generally understandable, non-technical summary of the EIA report.

Pilot wind turbines are dealt with exclusively within the framework of the environmental assessment in the approval procedure and not already at upstream stages.

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

In the staged planning process, the construction and operation of grid connections for offshore wind turbines (converter platform and submarine cable systems, if applicable) is examined at the level of approval procedures (plan approval and plan authorisation procedures) in implementation of the requirements of regional planning and the specifications of the FEP at the request of the respective developer - the responsible TSO.

Pursuant to sec. 44 para. 1 in conjunction with sec. 45 para. sec. 45 para. 1 WindSeeG, the construction and operation of facilities for the transmission of electricity require plan approval. In addition to the legal requirements of sec. 73 par. 1 sentence 2 VwVfG, the plan must include the information contained in sec. 47 par. 1 WindSeeG. The plan may only be approved under certain conditions listed in sec. 48 para. 4 WindSeeG and only if, inter alia, the marine environment is not endangered, in particular if there is no concern of pollution of the marine environment within the meaning of Article 1 (1) No. 4 of the Convention on the Law of the Sea and bird migration is not endangered.

In all other respects, the requirements for the environmental impact assessment of offshore wind turbines, including ancillary installations, shall apply mutatis mutandis to the environmental assessment pursuant to Article 1(4) UVPG.

1.3.4.6 Cross-border submarine cable systems

Pursuant to sec. 133 para. 1 in conjunction with sec. 133 para. 4 BBergG. Para. 4 BBergG, the construction and operation of a submarine cable in or on the continental shelf requires a permit.

- in mining terms (by the competent state mining office) and
- with regard to the ordering of the use and enjoyment of the waters above the continental shelf and of the airspace above these waters (by the BSH).

Pursuant to sec. 133 para. 2 BBergG, the above-mentioned permits may only be refused if there is a risk to the life or health of persons or to material goods or an impairment of overriding public interests which cannot be prevented or compensated for by a time limit, by conditions or obligations. An impairment of overriding public interests exists in particular in the cases mentioned in sec. 132 para. 2 no. 3 BBergG. Pursuant to sec. 132 para. 2 no. 3 (b) and (d) BBergG, an impairment of overriding public interests with regard to the marine environment exists in particular if the flora and fauna would be unacceptably impaired or if there is a risk of pollution of the sea.

According to sec. 1 para. 4 UVPG, the essential requirements of the UVPG must be observed for the construction and operation of transboundary submarine cable systems.

Tabular overview of environmental audits: Focus of the audits

Spatial planning SUP	FEP SUP	Preliminary investigation SUP suitability test	Admission procedure (planning approval or planning permission) Grid connections UP	Approval procedure Cross-border submarine cable systems UP
Strategic planning for the determinations	**Strategic planning for the determinations**	**Strategic Determination of suitability for areas with wind turbines**	**Environmental assessment Request for**	**Environmental assessment Request for**
Determinations and subject of the audit				
Priority and reserved areas • to ensure the safety and ease of shipping traffic, • to further economic uses. especially offshore wind energy and pipelines. • on scientific uses and Protection and enhancement of the marine environment Goals and principles Application of the ecosystem approach	• Areas for offshore wind turbines • Areas for offshore wind turbines, including the expected capacity to be installed. • Locations platforms • Routes and route corridors for submarine cable systems • Technical and planning principles	• Examination of the suitability of the area for the erection and operation of wind turbines, including the power to be installed. • On the basis of the ceded and collected data (STUK) as well as other information that can be determined with reasonable effort • Specifications, in particular on the type, extent and location of the development	• the construction and operation of platforms and connection lines • in accordance with the requirements of regional planning and the land development plan	• the construction and operation of cross-border submarine cable systems • according to the requirements of spatial planning and the FEP
Environmental impact analysis				
Analyses (identifies, describes and assesses) the likely significant effects of the plan on the marine environment.	Analyses (identifies, describes and assesses) the likely significant environmental effects of the plan on the marine environment.	Analyses (identifies, describes and assesses) the likely significant environmental effects for the construction and operation of wind turbines, which can be assessed independently of the subsequent design of the project, using model assumptions	Analyses (identifies, describes and evaluates) the environmental impacts of the specific project (platform and connection line, if applicable).	Analyses (identifies, describes and evaluates) the environmental impacts of the specific project.
Destination				
Aims to optimise overall planning solutions, i.e. comprehensive bundles of measures. Consideration of a wider range of uses.	For the use of offshore wind energy, deals with the fundamental issues according to the • Need or legal objectives • Purpose • Technology • Capacities • Finding locations for platforms and routes.	For the use of wind turbines, deals with the fundamental questions according to • Capacity • Suitability of the area	Deals with questions about the concrete design ("how") of a project (technical equipment, construction - building permits). Assesses the environmental compatibility of the project and formulates conditions.	Deals with questions about the concrete design ("how") of a project (technical equipment, construction - building permits). Assesses the environmental impact

Starts at the beginning of the planning process to clarify basic strategic issues, i.e. at an early stage when there is still more room for manoeuvre.	Searches for environmentally sound bundles of measures without making an absolute assessment of the environmental compatibility of the planning.	Provides the information on the area regulated by law for the submission of tenders. Searches for environmentally sound bundles of measures without assessing the environmental compatibility of the specific project.		of the project and formulates conditions for it.
Essentially functions as a steering planning instrument for the planning authorities to create an environmentally sound framework for all uses.	Functions predominantly as a steering planning instrument to create an environmentally sound framework for the realisation of individual projects (wind turbines and grid connections, cross-border submarine cables).	Acts as an instrument between the FEP and the approval procedure for wind turbines on a specific site.	Functions primarily as a passive testing instrument that, upon application of the developer.	Functions primarily as a passive revie tool that responds to the developer's r quest.
Depth of inspection				
Characterised by greater breadth of investigation, i.e. a larger number of alternatives, and less depth of investigation (no detailed analyses). Considers spatial, national and global impacts as well as secondary, cumulative and synergistic impacts in the sense of an overall view.	Characterised by greater breadth of investigation, i.e. greater number of alternatives, and less depth of investigation (no detailed analyses). Considers local, national and global impacts as well as secondary, cumulative and synergistic impacts in terms of an overall view.	Characterised by a smaller study area, greater depth of investigation (detailed analyses). The suitability determination may include specifications for the subsequent project, in particular on the type and extent of development of the site and its location.	Characterised by narrower scope of investigation (limited number of alternatives) and greater depth of investigation (detailed analyses). Assesses the environmental compatibility of the project and formulates conditions. Primarily considers local impacts in the vicinity of the project.	Characterised by narrower scope of investigation (limited number of alternatives) and greater depth of investigation (detailed analyses). Primarily considers local impacts in the vicinity of the project.
Focus of the audit				
Cumulative effects Overall plan view Strategic and large-scale alternatives Possible cross-border effects	**Cumulative effects** Overall plan view Strategic, technical and spatial alternatives Possible cross-border effects	**Local impacts** related to the area and its location.	Plant, construction and operational environmental impacts Plant dismantling Testing in relation to the specific system design. Intervention, compensation and replacement measures.	Plant, construction and operational environmental impacts Testing in relation to the specific system design. Intervention, compensation and replacement measures.

Approval procedure (planning approval or planning permission) for wind turbines

MSRP

Subject of the audit

Environmental impact assessment on application for

- the construction and operation of wind turbines
- on the area defined and pre-surveyed in the FEP

- According to the determinations of the FEP and specifications of the preliminary investigation.

Environmental impact assessment

Analyses (identifies, describes and evaluates) the environmental impacts of the specific project (wind turbines, platforms if applicable, and cabling within the park).

Pursuant to sec. 24 UVPG, the competent authority shall prepare a summary presentation

- the environmental impact of the project,
- the characteristics of the project and the site that are intended to exclude, mitigate or compensate for **significant adverse environmental effects,**
- the measures to exclude, reduce or compensate for significant adverse environmental effects, and
- of compensatory measures in the case of interventions in nature and landscape (Note: Exception according to sec. 56 para. 3 BNatSchG

Destination

Deals with the questions of the concrete design ("how") of a project (technical equipment, construction).

Functions primarily as a passive review tool that responds to the request of the tender winner/project sponsor.

Depth of inspection

Characterised by narrower scope of investigation, i.e. a limited number of alternatives, and greater depth of investigation (detailed analyses).

Assesses the environmental compatibility of the project on the pre-surveyed area and formulates conditions for this.

Considers mainly local impacts in the vicinity of the project.

Focus of the audit

The focus of the audit is on:

- Construction and operational environmental impacts.
- Testing in relation to the specific system design.
- Plant dismantling.

Figure 3: Overview of focal points in environmental assessments in planning and approval procedures.

1.3.5 Lines

At the upper level is the instrument of spatial planning. Within this framework, areas or corridors for pipelines and data cables are defined.

Pursuant to sec. 8 para. 1 ROG, the likely significant impacts of the determinations on pipelines on the objects of protection must be identified, described and assessed.

Pursuant to sec. 133 para. 1 i.V.m. (4) BBergG, the construction and operation of a transit pipeline or an underwater cable (data cable) in or on the continental shelf requires a permit.

- in mining terms (by the competent state mining office) and
- with regard to the ordering of the use and enjoyment of the waters above the continental shelf and of the airspace above these waters (by the BSH).

Pursuant to sec. 133 para. 2 BBergG, the above-mentioned permits may only be refused if there is a risk to the life or health of persons or to material goods or an impairment of overriding public interests which cannot be prevented or compensated for by a time limit, by conditions or obligations. An impairment of overriding public interests exists in particular in the cases specified in sec. 132 para. 2 no. 3 BBergG. Pursuant to sec. 132 para. 2 no. 3 (b) and (d) BBergG, an impairment of overriding public interests with regard to the marine environment exists in particular if the flora and fauna would be unacceptably impaired or if there is a risk of pollution of the sea.

Pursuant to sec. 133 para. 2a BBergG, the construction and operation of a transit pipeline which is also a project within the meaning of sec. 1 para. 1 no. 1 UVPG shall be subject to an environmental impact assessment in the licensing procedure with regard to the ordering of the use and enjoyment of the waters above the continental shelf and the airspace above these waters in accordance with the UVPG.

According to sec. 1 para. 4 UVPG, the essential requirements of the UVPG must be observed for the construction and operation of data cables.

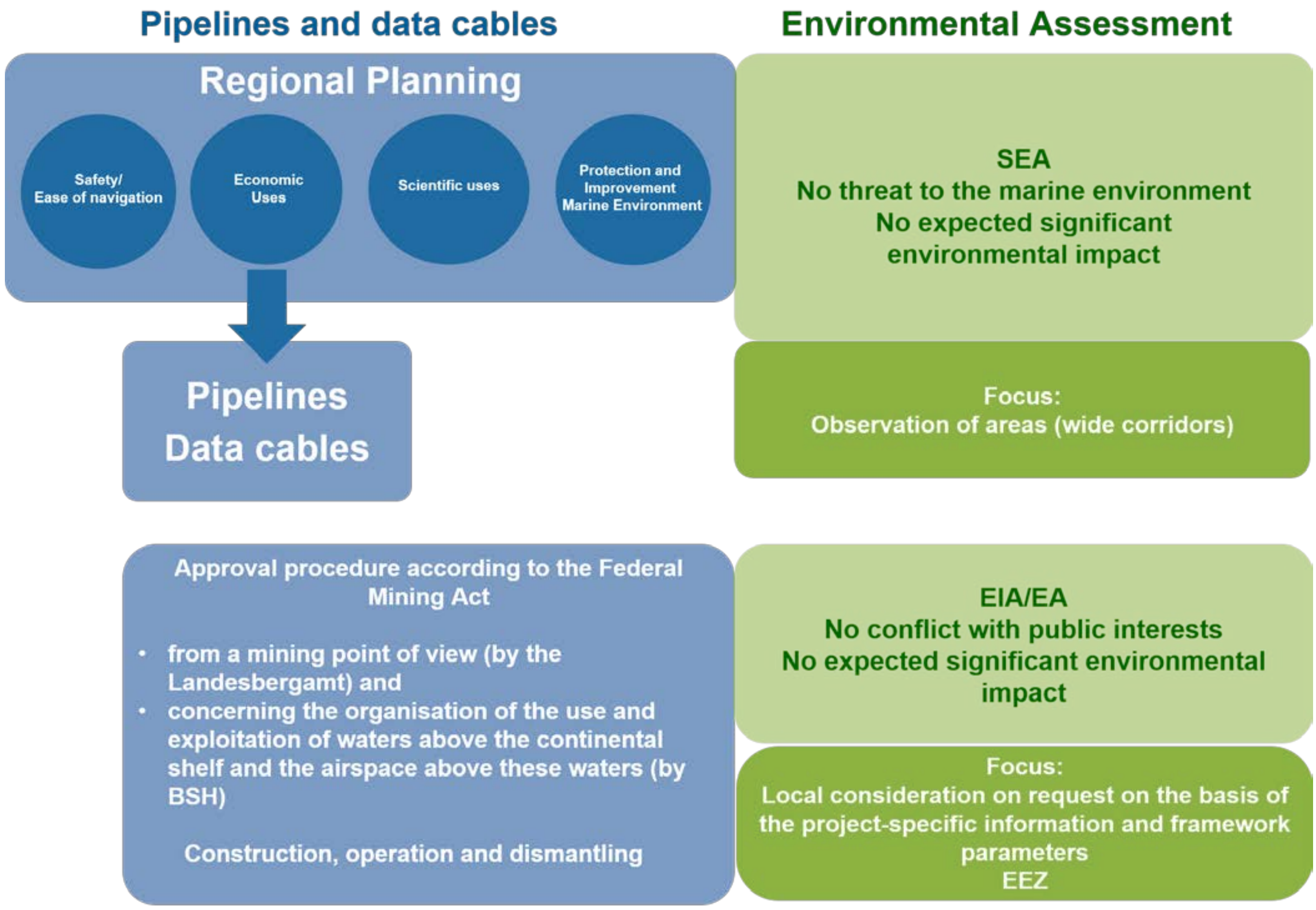


Figure 4: Overview of the focal points of the environmental assessment for pipelines and data cables.

1.3.6 Raw material extraction

In the German North Sea and Baltic Sea, various mineral resources are explored and extracted, e.g. sand, gravel and hydrocarbons. As a superordinate instrument, spatial planning deals with possible large-scale spatial designations, if necessary including other uses. The likely significant environmental impacts are assessed (cf. also Chapter 1.5.4).

Raw material extraction is regularly divided into different phases during implementation - exploration, development, operation and aftercare phases.

Exploration serves the exploration of raw material deposits according to sec. 4 para. 1 BBergG. In the marine area, it is carried out regularly by means of geophysical surveys, including seismic surveys and exploratory drilling. In the EEZ, the extraction of raw materials includes the extraction (dissolving, releasing), processing, storage and transport of raw materials.

For exploration in the area of the continental shelf, mining permits (permission, authorisation) must be obtained in accordance with the Federal Mining Act. These grant the right to explore for and/or extract mineral resources in a defined field for a specified period of time. Additional permits in the form of operating plans are required for development (extraction and exploration activities) (cf. sec. 51 BBergG). For the establishment and management of an operation, main operating plans must be drawn up for a period not exceeding 2 years as a rule, and must be continuously renewed as required (sec. 52 para. 1 sentence 1 BBergG).

In the case of mining projects that require an EIA, the preparation of an outline operating plan is obligatory, for the approval of which a plan approval procedure must be carried out (sec. 52 para. 2a BBergG). As a rule, general operating plans are valid for a period of 10 to 30 years.

The construction and operation of production platforms for the extraction of crude oil and natural gas in the area of the continental shelf require an EIA in accordance with sec. 57c BBergG in conjunction with the Ordinance on the Environmental Impact Assessment of Mining Projects (UVP-V Bergbau). The same applies to marine sand and gravel extraction on extraction areas of more than 25 ha or in a designated nature conservation area or Natura 2000 site.

The licensing authorities for the German EEZ of the North Sea and Baltic Sea are the Landesbergämter.

1.3.7 Shipping

In the context of spatial planning, the shipping sector is regularly defined in the form of areas (priority and/or reserved areas), objectives and principles. A staged planning and approval process, as is the case for the offshore wind energy sector, grid connections, cross-border submarine cables, pipelines and data cables, does not exist for the shipping sector.

With regard to the consideration of the likely significant impacts of the provisions on the shipping sector, reference is made to Chapter 1.5.4.3

1.3.8 Fisheries and marine aquaculture

Fisheries and aquaculture are considered concerns within the framework of spatial planning. There is no staged planning and authorisation process. The framework conditions for permissible catches, fishing techniques and gear are set within the framework of the EU's Common Fisheries Policy (CFP).

With regard to the consideration of the likely significant impacts, reference is made to Chapter 1.5.4.3

1.3.9 Marine science

Marine scientific research projects can have negative impacts on the marine environment, e.g. through underwater sound generated during seismic surveys. On its website, the BfN mentions, among other things, the construction of artificial islands, installations or structures, the use of explosives, or measures with direct relevance to the exploration and exploitation of resources, which are in principle likely to have a significant impact on the site and must be assessed for their compatibility with the conservation purpose of potentially affected Natura 2000 protected areas prior to approval.

In this case, a nature conservation assessment and approval is also required as part of the approval procedure. Notification is required for projects that do not require approval and that may significantly affect Natura2000 sites.

In the reserved areas for research, the Thünen Institute, under the technical supervision of the BMEL, predominantly conducts fisheries research, especially within the framework of the CFP and reporting obligations under ICES. This is carried out within the framework of regular sampling over many years and does not require approval in the EEZ.

1.3.10 National and alliance defence

National and alliance defence is considered a concern in the context of spatial planning. A staged planning and approval process does not exist.

With regard to the consideration of the likely significant impacts, reference is made to Chapter 1.5.4.3

1.3.11 Leisure

The issue of leisure time is also considered. There is no staged planning and approval process.

With regard to the consideration of the likely significant impacts, reference is made to Chapter 1.5.4.3

1.4 Presentation and consideration of the goals of environmental protection

The preparation of the ROP and the implementation of the SEA take into account environmental protection objectives. These provide information on the environmental status to be aimed for in the future (environmental quality objectives). The environmental protection objectives can be derived from an overall view of the international, EU and national conventions and regulations that deal with marine environmental protection and on the basis of which the Federal Republic of Germany has committed itself to certain principles and objectives. The environmental report will contain a description of how compliance with the requirements will be checked and what stipulations or measures will be taken.

1.4.1 International conventions on marine environmental protection

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 the protection of the marine environment in whole or in part

- Convention for the Prevention of Pollution from Ships, 1973, as amended by the Protocol of 1978 (MARPOL 73/78).
- 1982 United Nations Convention on the Law of the Sea
- Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London, 1972) and the 1996 Protocol

1.4.1.2 Regional agreements on marine environmental protection

- Trilateral Wadden Sea Cooperation (1978) and Trilateral Monitoring and Assessment Programme of 1997 (TMAP)
- Convention for Co-operation between North Sea States in Combating Pollution of the North Sea by Oil and Other Harmful Substances, 1983 (Bonn Convention)
- Convention for the Protection of the Marine Environment of the North-East Atlantic, 1992 (OSPAR Convention)

1.4.1.3 Agreements specific to protected goods

- Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) 1979
- Convention on the Conservation of Migratory Species of Wild Animals 1979 (Bonn Convention)

Within the framework of the Bonn Convention, regional agreements on the conservation of the species listed in Appendix II were concluded in accordance with Art. 4 No. 3 Bonn Convention:

- Agreement on the Conservation of African-Eurasian Migratory Waterbirds 1995 (AEWA)
- Agreement on the Conservation of Small Cetaceans of the North Sea and Baltic Sea of 1991 (ASCOBANS)
- Agreement on the Conservation of Seals in the Wadden Sea of 1991
- Agreement on the Conservation of European Bat Populations of 1991 (EUROBATS)
- Convention on Biological Diversity 1993

1.4.2 Environmental and nature conservation requirements at EU level

The relevant EU legislation to be taken into account is:

- Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning (MSP 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 (Environmental Impact Assessment Directive, EIA Directive),
- Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (Habitats Directive),
- Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (Water Framework Directive, WFD),
- 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),
- 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 2009/147/EC of the European Parliament and of the Council on the conservation of wild birds (Birds Directive, Birds Directive).

1.4.3 Environmental and nature conservation requirements at national level

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

- Nature Conservation and Landscape Management Act (Bundesnaturschutzgesetz - BNatSchG)
- Water Resources Act (WHG)
- Environmental Impact Assessment Act (UVPG)
- Ordinance on the Establishment of the Nature Reserve "Sylt Outer Reef - Eastern German Bight", the Ordinance on the Establishment of the Nature Reserve "Borkum Riffgrund", and the Ordinance on the Establishment of the Nature Reserve "Dogger Bank" in the North Sea EEZ
- Management plans for nature conservation areas in the German EEZ of the North Sea
- Energy and climate protection targets of the Federal Government

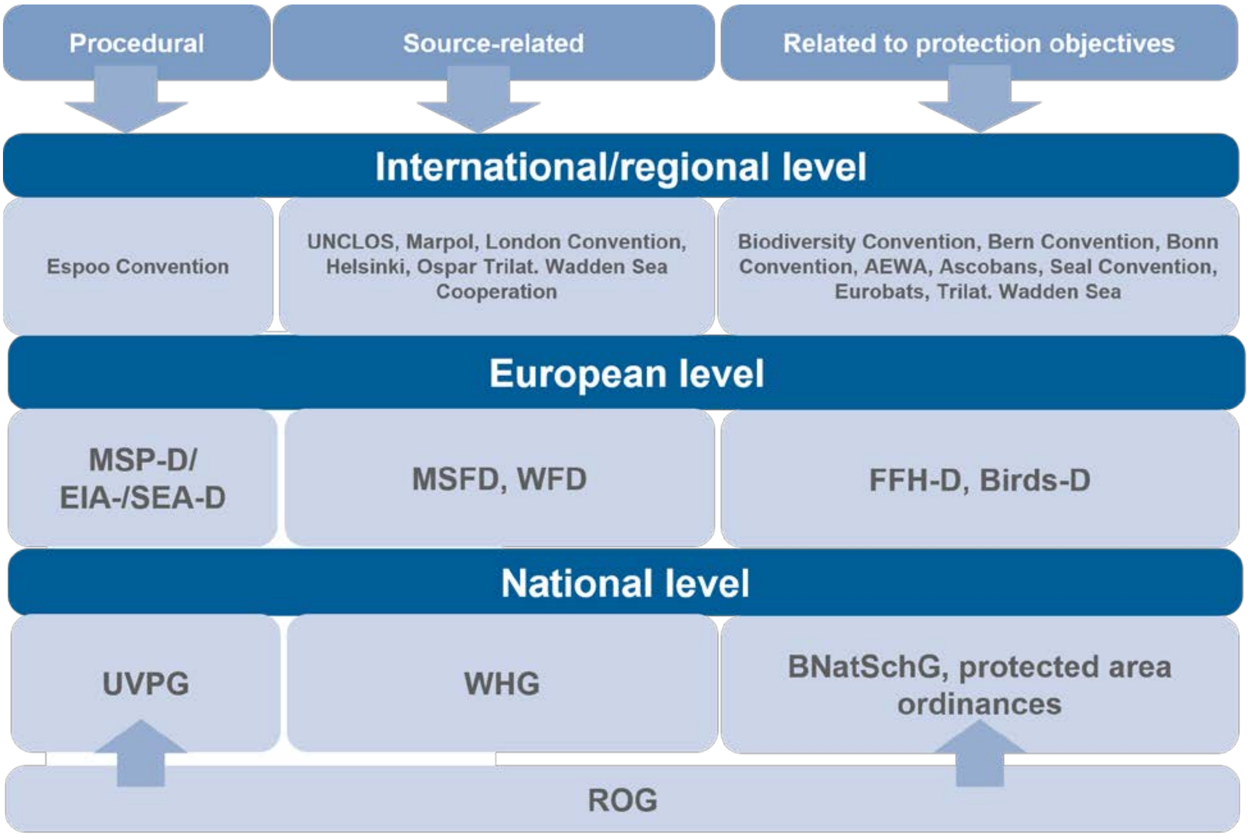


Figure 5: Overview of the norm levels of the relevant legal acts for SEA.

1.4.4 Supporting the objectives of the Marine Strategy Framework Directive

Spatial planning can support the implementation of individual objectives of the MSFD and thus contribute to a good environmental status in the North Sea and the Baltic Sea.

The following environmental goals (BMUB 2016) are taken into account when defining goals and principles:

- o Environmental Objective 1: Seas free from degradation caused by anthropogenic eutrophication: Consideration in the objectives and principles to ensure the safety and ease of navigation.
- o Environmental Goal 3: Seas not impaired by the impacts of human activities on marine species and habitats: Consideration in the objectives and principles on offshore wind energy and nature conservation
- o Environmental Goal 6: Seas free from degradation by anthropogenic energy inputs: Consideration in the objectives and principles on offshore wind energy and power lines

The environmental assessment formulates avoidance and mitigation measures that support Objectives 1, 3 and 6.

In addition, the maritime spatial plan counteracts a deterioration of the environmental status by allowing certain uses only in spatially delimited areas and limited in time. The principles of environmental protection must be taken into account. At the licensing level, the design of the use is specified with conditions, if necessary, in order to avert negative impacts on the marine environment.

An essential basis of the MSFD is the ecosystem approach regulated in Article 1 (3) MSFD, which ensures the sustainable use of marine ecosystems by managing the overall impact of human activities in a way that is compatible with the achievement of good environmental status. The application of the ecosystem approach is described in Chapter 4.3.

1.5 Methodology of the Strategic Environmental Assessment

In principle, various methodological approaches can be considered when carrying out the strategic environmental assessment. This environmental report builds on the methodology already used for the strategic environmental assessment of the sectoral federal plans and the land development plan with regard to the use of offshore wind energy and electricity grid connections.

For all other uses for which specifications are made in the ROP, such as shipping, raw material extraction and marine research, sector-specific criteria are used as the basis for an assessment of possible impacts.

The methodology depends primarily on the provisions of the plan to be assessed. Within the framework of this SEA, it is determined, described and assessed for the individual specifications whether the specifications are likely to have significant effects on the objects of protection concerned. According to sec. 1 para. 4 UVPG in conjunction with sec. 40 para. 3 UVPG. Sec. 40 para. 3 UVPG, the competent authority shall provisionally assess the environmental effects of the specifications in the environmental report with a view to effective environmental precaution in accordance with the applicable legislation. Criteria for the assessment can be found, inter alia, in Annex 2 of the Spatial Planning Act.

The subject of the environmental report is the description and assessment of the likely significant impacts of the implementation of the ROP on the marine environment for specifications on the use and protection of the EEZ. The assessment is carried out in relation to the respective protected goods.

Pursuant to sec. 7 para 1 ROG, spatial plans must define spatial development **objectives and principles for** the development, organisation and safeguarding of space, in particular for the uses and functions of space. According to sec. 7 para. 3 ROG, these specifications may also designate areas.

The following uses are the subject of the environmental report, in particular:

- Shipping
- Wind energy at sea
- Lines
- Raw material extraction
- Fisheries and marine aquaculture
- Marine research
- Nature Conservation / Seascape / Open Space
- National and alliance defence

Pursuant to sec. 17 para. 1 No.4 ROG, specifications for the protection and improvement of the marine environment also play a role.

1.5.1 Study area

The description and assessment of the environmental status relates to the North Sea EEZ, for which the maritime spatial plan makes specifications. The SEA study area covers the German North Sea EEZ (Figure 7). It should be noted that the data situation within the North Sea EEZ is significantly better for the area up to shipping route 10 than for the area northwest of shipping route 10 due to the available project-related monitoring data.

The maritime spatial plan also makes specifications for the area northwest of shipping route 10. Based on the available sediment data and findings from the monitoring of the "Dogger Bank" protected area, a description and assessment of the environmental status and an evaluation of the potential environmental impacts is also possible for this area.

The adjacent territorial sea and the adjacent areas of the riparian states are not the subject of this plan, but they are included as part of the cumulative and transboundary consideration in this SEA.

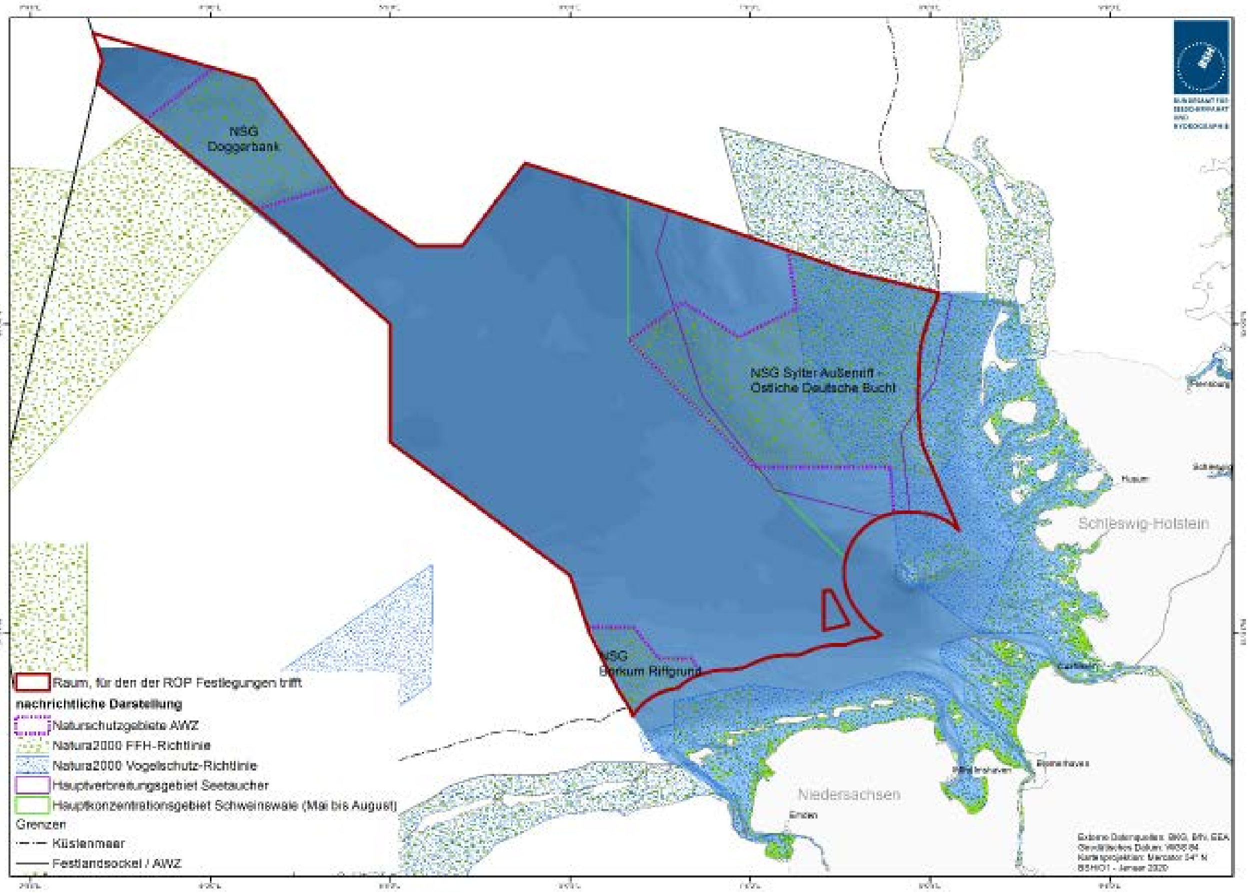


Figure 6: Delimitation of the study area for the SEA (Environmental Report ROP EEZ North Sea).

1.5.2 Implementation of the environmental assessment

The assessment of the likely significant environmental effects of the implementation of the maritime spatial plan includes secondary, cumulative, synergetic, short-, medium- and long-term, permanent and temporary, positive and negative effects in relation to the protected assets. Secondary or indirect effects are those that do not take effect immediately and thus possibly only after some time and/or at other locations. Occasionally, we also speak of consequential effects or interactions.

Possible impacts of plan implementation are described and assessed in relation to the protected goods. A uniform definition of the term "significance" does not exist, since it is a matter of "individually determined significance in each case", which cannot be considered independently of the "specific characteristics of plans or programmes" (SOMMER, 2005, 25f.). In general, significant impacts can be understood as those effects that are severe and significant in the context under consideration.

According to the criteria of Annex 2 of the ROG, which are relevant for the assessment of the likely significant environmental impacts, the significance is determined by:

- "the likelihood, duration, frequency and irreversibility of the effects;
- the cumulative nature of the effects;
- the transboundary 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 impact;
- the importance and sensitivity of the area likely to be affected because of its special natural features or cultural heritage, the exceeding of environmental quality standards or limit values, and intensive land use;

- the impact on sites or landscapes whose status is recognised as nationally, community or internationally protected".

Furthermore, the characteristics of the plan are also relevant, in particular with regard to

- 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 in integrating environmental considerations, particularly with a view to promoting sustainable development;
- the environmental issues relevant to the plan;
- the relevance of the plan for the implementation of Community environmental legislation (e.g. plans and programmes concerning waste management or water protection) (Annex II SEA Directive).

In some cases, further specifications on when an impact reaches the materiality threshold are derived from sectoral legislation. Thresholds have been developed in sub-legislation in order to be able to make a distinction.

The description and assessment of the potential environmental impacts is carried out for the individual spatial and textual specifications on the use and protection of the EEZ in relation to the protected goods, taking into account the status assessment.

Furthermore, where necessary, a differentiation is made according to different technical designs. The description and assessment of the likely significant effects of the implementation of the plan on the marine environment also refer to the protected interests presented. All plan contents that can potentially have significant environmental impacts are examined.

Both permanent and temporary, e.g. construction-related, effects are considered. This is followed by a presentation of possible interactions, a consideration of possible cumulative effects and potential transboundary impacts.

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

- Area
- Floor
- Water
- Plankton
- Biotope types
- Benthos
- Fish
- Marine mammals
- Avifauna
- Bats
- Biodiversity
- Air
- Climate
- Landscape
- Cultural and other material assets (underwater cultural heritage)
- People, especially human health
- Interactions between protected goods

In general, the following methodological approaches find their way into the environmental assessment:

- Qualitative descriptions and evaluations
- Quantitative descriptions and evaluations
- Evaluation of studies and specialist literature, expert opinions
- Visualisations
- Worst-case assumptions
- Trend assessments (e.g. on the state of the art of installations and the possible development of shipping traffic)
- Assessments by experts/ the professional public

An assessment of the impacts of the provisions of the plan is carried out on the basis of the status description and status assessment and the function and significance of the individual areas for the individual objects of protection on the one hand and the effects and resulting potential impacts of these provisions on the other. A forecast of the project-related impacts in the case of implementation of the ROP is made depending on the criteria of intensity, range and duration or frequency of the effects (cfFigure 7). Further assessment criteria are the likelihood and reversibility of the effects as set out in Annex 2 to sec. 8 (2) of the ROG.

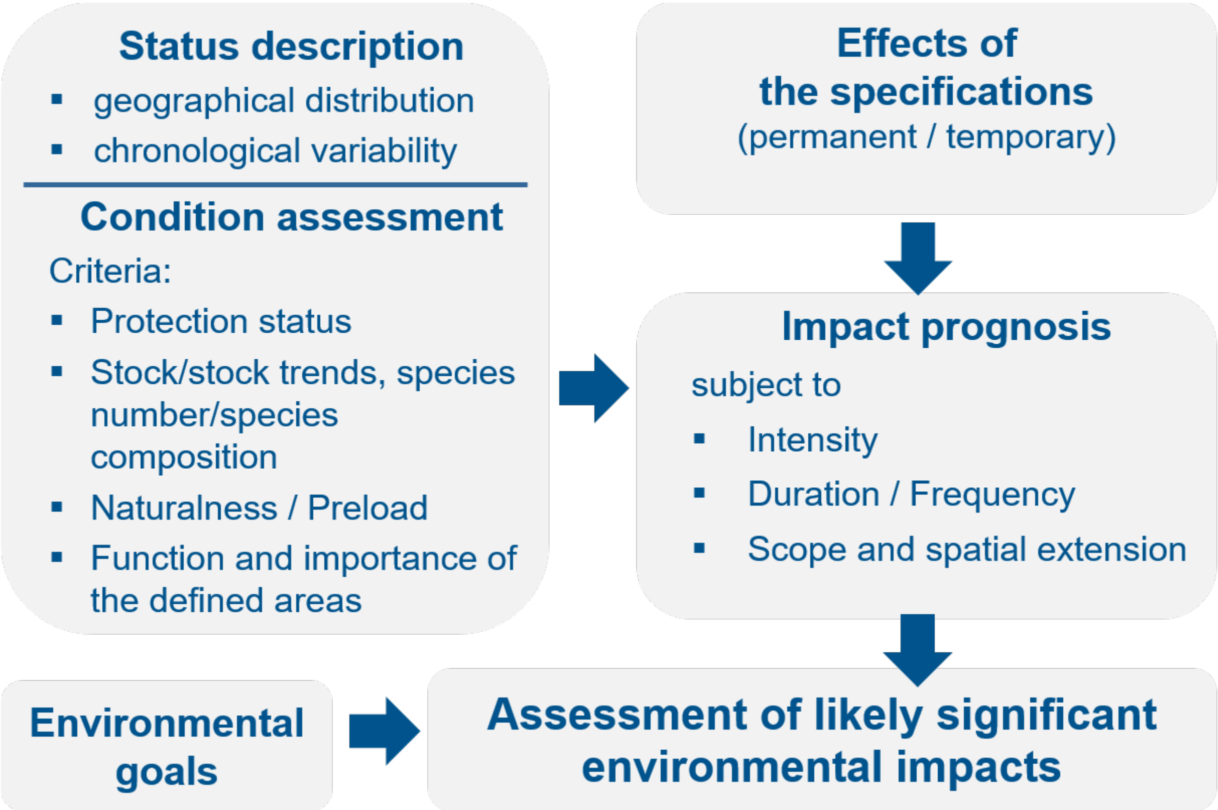


Figure 78: General methodology for the assessment of likely significant environmental effects.

1.5.3 Criteria for condition description and condition assessment

The assessment of the status of the individual protected assets is carried out on the basis of various criteria. For the protected assets surface/soil, benthos and fish, the assessment is based on the aspects of rarity and endangerment, diversity and specificity, and existing pressures. The description and assessment of the protected goods marine mammals and seabirds and resting birds is based on the aspects listed in the figure. As these are highly mobile species, an approach analogous to that for the protected goods surface/soil, benthos and fish is not expedient. For seabirds and resting birds and marine mammals, the criteria of protection status, assessment of occurrence, assessment of spatial units and existing pressures are used as a basis. For migratory birds, in addition to rarity and endangerment and existing pressures, the aspects of assessment of occurrence and large-scale importance of the area for bird migration are considered. For bats, there is currently no reliable data available for a criteria-based assessment. The biodiversity site is assessed textually.

The following is a list of the criteria used to assess the status of the respective protected assets. This overview deals with the protected assets that can be meaningfully delimited on the basis of criteria and are considered in the focus.

Surface/Floor

Aspect: Rarity and endangerment
Criterion: areal proportion of sediments on the seabed and distribution of the morphological form inventory.
Aspect: Diversity and Eigenart
Criterion: Heterogeneity of the sediments on the seabed and formation of the morphological form inventory.
Aspect: Preload
Criterion: Extent of anthropogenic preloading of seabed sediments and morphological form inventory.

Benthos

Aspect: Rarity and endangerment
Criterion: Number of rare or endangered species based on the Red List species detected (Red List by RACHOR et al. 2013).
Aspect: Diversity and Eigenart
Criterion: Number of species and composition of species communities. The extent to which species or communities characteristic of the habitat occur and how regularly they occur is assessed.
Aspect: Preload
For this criterion, the intensity of fishing use, which represents the most effective direct disturbance variable, is used as an assessment criterion. Furthermore, benthic communities can be impaired by eutrophication. For other disturbance variables, such as shipping traffic, pollutants, etc., suitable measurement and detection methods are still lacking in order to be able to include them in the assessment.

Biotope types

Aspect: Rarity and endangerment
Criterion: national protection status as well as endangerment of the biotope types according to the Red List of Endangered Biotope Types of Germany (FINCK et al., 2017).
Aspect: Preload
Criterion: Endangerment by anthropogenic influences.

Fish

Aspect: Rarity and endangerment
Criterion: Proportion of species that are considered endangered according to the current Red List of marine fishes (THIEL et al. 2013) and for the diadromous species of the Red List of freshwater fishes (FREYHOF 2009) and have been assigned to Red List categories.

Aspect: Diversity and Eigenart
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 distinctiveness of a fish community, i.e. how regularly habitat-typical species occur. Diversity and species richness are compared and assessed between the entire North Sea and the German EEZ as well as between the EEZ and the individual areas.
Aspect: Preload
Criterion: Due to the removal of target species and bycatch, as well as the impact on the seabed in the case of bottom-disturbing fishing methods, fishing is considered the most effective disturbance to the fish community and therefore serves as a measure of the pre-existing pressure on fish communities in the North Sea. An assessment of stocks at a smaller spatial scale, such as the German Bight, is not carried out. The input of nutrients into natural waters is another pathway through which human activities can influence fish communities. Therefore, eutrophication is used to assess the pre-stress.

Marine mammals

Aspect: Protection status
Criterion: Status according to Annex II and Annex IV of the Habitats Directive and the following international conservation 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: Assessment of spatial units
Criteria: Function and importance of the German EEZ and the areas identified in the FEP for marine mammals as a migration area, feeding or breeding ground.
Aspect: Preload
Criterion: Hazards due to anthropogenic influences and climate change.

Seabirds and resting birds

Aspect: Protection status
Criterion: Status according to Annex I species of the Birds Directive, European Red List of BirdLife International
Aspect: Assessment of occurrence
Criteria: German North Sea stock and German EEZ stock, large-scale distribution patterns, abundance, variability
Aspect: Assessment of spatial units

Criteria: Function of the areas identified in the FEP for relevant breeding birds, migratory birds, as resting areas, location of the protected areas.
Aspect: Preload
Criterion: Hazards due to anthropogenic influences and climate change.

Migratory birds

Aspect: Large-scale importance of bird migration
Criterion: Guidelines and concentration areas
Aspect: Assessment of occurrence
Criterion: migratory activity and its intensity
Aspect: Rarity and endangerment
Criterion: Number of species and endangerment status of the species involved according to Annex I of the Birds Directive, 1979 Bern Convention on the Conservation of European Wildlife and Natural Habitats, 1979 Bonn Convention on the Conservation of Migratory Species of Wild Animals, AEWA (African-Eurasian Waterbird Agreement) and SPEC (Species of European Conservation Concern).
Aspect: Preload
Criterion: Existing pressures/ hazards due to anthropogenic influences and climate change.

1.5.4 Assumptions for the description and assessment of the likely significant impacts

The description and assessment of the likely significant effects of the implementation of the ROP on the marine environment is carried out for the individual specifications for the use and protection of the EEZ in relation to the protected goods, taking into account the status assessment described above. The following table lists, based on the main impact factors, the potential environmental impacts that arise from the respective use and are to be assessed both as an existing impact, in the event of non-implementation of the plan, or as a likely significant environmental impact as a result of the specifications in the ROP. The impacts are differentiated according to whether they are permanent or temporary.

Table 1: Overview of the potentially significant impacts of the uses identified in the maritime spatial plan.

Use	Effect	Potential impact	Protected goods																
			Benthos	Fish	Seabirds and	Migratory birds	Marine mammals	Bats	Plankton	Biotope types	Biodiversity	Floor	Area	Water	Air	Climate	Man/ Health	Cultural and mate-	Landscape
Marine uses with spatial designations in the maritime spatial plan																			
Areas for offshore wind energy	Placement of hard substrate (foundations)	Habitat modification	x	x			x		x	x	x	x							
		Habitat and land loss	x	x			x			x	x	x	x					x	
		Attraction effects, increase in species diversity, change in species composition	x	x	x		x		x		x								
		Change in hydrographic conditions	x	x			x		x					x					
	Scouring/sediment rearrangement	Habitat modification	x	x					x	x		x	x						
	Sediment resuspension and turbidity plumes (construction phase)	Impairment	x t	x t	x t				x t					x t					
		Physiological effects and chilling effects		x t			x												
	Resuspension of sediment and sedimentation (construction phase)	Impairment	x t	x t					x t					x t					
	Noise emissions during pile driving (construction phase)	Impairment/ scare effect		x t			x												
		Potential disruption/damage		x t			x												
	Visual disturbance due to construction operations	Local scouring and barrier effects		x t	x t														

	Obstacle in airspace	Scare effects, habitat loss			x														
		Barrier effect, collision			x	x		x											x
	Light emissions (construction and operation)	Attraction effects, collision			x	x		x											x
	Wind farm-related shipping traffic (maintenance, construction traffic)	See Shipping	x	x	x	x	x	x	x	x	x	x	x t	x	x	x	x	x	
Lines Routes for submarine cable systems and pipelines	Placement of hard substrate (riprap)	Habitat modification	x	x					x	x		x						x	
		Habitat and land loss	x	x						x		x	x					x	
	Heat emissions (live cables)	Impairment/displacement of cold-water-loving species	x								x	x							
	Magnetic fields (live cables)	Impairment	x																
		Impairment of the orientation behaviour of individual migratory species		x															
	Turbidity plumes (construction phase)	Impairment	x t	x t	x t				x t					x t					
		Physiological effects and chilling effects		x t															
Shipping	Underwater sound	Impairment / scare effect		x			x												
	Emissions and discharges of hazardous substances (accidents)	Impairment/ Damage	x	x	x		x		x	x	x	x		x			x		
	Physical disturbance during anchoring	Impact on the seabed	x t							x t		x t	x t					x	
	Emission of air pollutants	Impairment of air quality			x	x		x							x	x	x		
	Introduction and spread of invasive species	Change in species composition	x	x	x				x		x								
	Bringing in rubbish	Impairment/ Damage	x	x	x		x		x					x			x		
	Collision risk	Collision			x	x	x												
	Visual restlessness	Impairment/ scare effect		x	x														

Raw materials Sand and gravel mining / Seismic surveys	Substrate removal	Habitat modification	x	x			x		x	x	x	x						x	
		Habitat and land loss	x	x			x		x	x	x	x	x					x	
	Turbidity plumes	Impairment	x t	x t	x t				x t					x t					
		Physiological effects and		x t															

		chilling effects																	
	Physical disorder	Impact on the seabed	x							x		x	x					x	
	Underwater sound during seismic surveys	Impairment / scare effect		x t			x												
	Visual restlessness	Impairment/ scarecrow effect			x														
Marine research	Removal of selected species	Reduction of stocks		x															
Marine research	Physical disturbance by trawls	Harm/ damage By-catch	x	x						x		x						x	
Fishing	Removal of selected species	Reduction of stocks	x	x							x								
Fishing	Removal of selected species	Degradation of the food base			x														
Fishing	Bycatch	Reduction of stocks	x	x	x		x				x								
Fishing	Physical disturbance by trawls	Impairment/ Damage	x	x			x			x		x						x	
National defence	Underwater sound	Impairment/ scare effect		x t			x												
National defence	Introduction of dangerous substances	Impairment	x	x	x		x		x	x	x	x		x			x		
National defence	Collision risk	Collision					x												
National defence	Surrounding water sound	Impairment/ scare effect			x	x		x									x		
National defence	Bringing in rubbish	Impairment	x	x					x					x			x		
Marine uses without spatial designations in the maritime spatial plan																			
Leisure (-traffic)	Removal of species (angling)	Reduction of stocks		x															
Leisure (-traffic)	Underwater sound	Impairment / scare effect		x			x												
Leisure (-traffic)	Emission of air pollutants	Impairment of air quality			x	x		x							x	x	x		
Leisure (-traffic)	Bringing in rubbish	Impairment	x	x	x		x		x					x			x		
Leisure (-traffic)	Visual restlessness	Impairment/ scare effect			x														
Aquaculture	Introduction of nutrients	Impairment	x	x					x					x					
Aquaculture	Bringing in fixed installations	Habitat modification	x	x					x	x	x								x
Aquaculture	Bringing in fixed installations	Habitat and land loss	x	x	x					x			x					x	x
Aquaculture	Introduction and spread of invasive species	Change in species composition	x	x	x				x		x								

	Insertion of medicines	Impairment	x	x										x			x		
	Removal from wild stocks	Impairment	x	x															
	Attraction/shying effects	Attraction / scare effect		x	x		x												

x Potential impact on the protected good

x tpotential temporary impact on the protected good

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

1.5.4.1 Cumulative view

According to Art.5 para.1 SEA Directive, the environmental report also includes the assessment of cumulative effects. Cumulative effects result from the interaction of various independent individual effects that either add up through their interaction (cumulative effects) or reinforce each other and thus produce more than the sum of their individual effects (synergetic effects) (e.g. SCHOMERUS et al., 2006). Cumulative as well as synergetic effects can be caused by temporal as well as spatial coincidence of effects. The effect can be intensified by similar uses or different uses with the same effect and thus increase the impact on one or more protected goods.

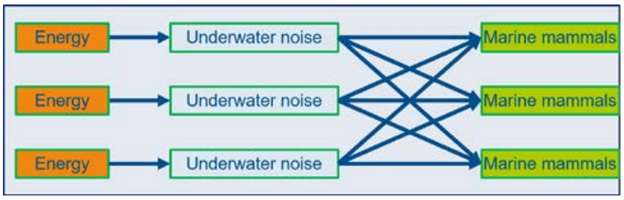


Figure 9: Exemplary cumulative effect of similar uses.

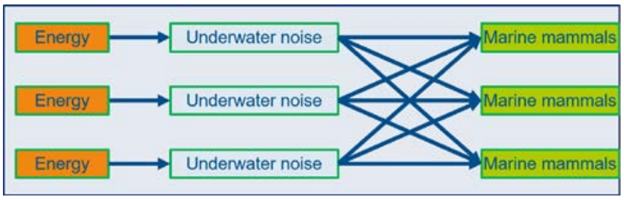


Figure 10: Exemplary cumulative effect of different uses.

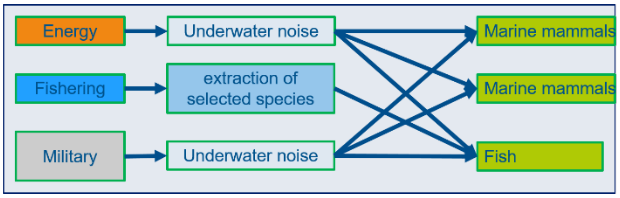


Figure 11: Exemplary cumulative effect of different uses with different impacts.

In order to assess the cumulative effects, it is necessary to evaluate the extent to which a significant adverse effect can be attributed to the provisions of the plan in combination. An assessment of the specifications is carried out on the basis of the current state of knowledge within the meaning of Article 5 (2) of the SEA Directive. The position paper on the cumulative assessment of diver habitat loss in the German North Sea (BMU, 2009) and the noise protection concept of the BMUB (2013) form an important basis for the assessment of impacts due to habitat loss and underwater noise.

1.5.4.2 Interactions

In general, impacts on a protected good lead to various consequences and interactions between the protected goods. The main interdependence of the biotic protected goods exists via the food chains. Due to the variability of the habitat, interactions can only be described very imprecisely.

1.5.4.3 Specific assumptions for the assessment of the likely significant environmental effects

In detail, the analysis and examination of the respective determinations is carried out as follows:

Wind energy at sea

With regard to the priority and reserved areas for offshore wind energy, a worst-case scenario is assumed. In this SEA, certain parameters are assumed in the form of bandwidths, spatially separated according to zones 1 and 2 and zones 3 to 5, for a consideration related to protected goods. In detail, these are, for example, power per turbine [MW], hub height [m], rotor diameter [m] and total height [m] of the turbines.

In particular, the SEA takes into account the following input parameters:

- Plants already in operation or in the approval procedure (as reference and pre-pollution)

- Transfer of the average parameters of the installations commissioned in the last 5 years on the areas defined in the FEP 2019.
- Forecast of certain technical developments for the additional priority and reserved areas for offshore wind energy defined in the ROP on the basis of the parameters presented. It should be noted that these are only partly estimate-based assumptions, as the examination of project-specific parameters does not or cannot take place at SEA level.

Table 2: Parameters for the consideration of areas for offshore wind energy

Parameters WEA	**Bandwidth** *Zone 1 and 2*		**Bandwidth** *Zone 3-5*	
	from	to	from	to
Capacity per plant [MW]	5	12	12	20
Hub height [m]	100	160	160	200
Rotor diameter [m]	140	220	220	300
Total height [m]	170	270	270	350

For the connection lines of the priority areas for offshore wind energy, the route length (EEZ) varies between around 10 km and 160 km. For the reserved areas in zones 4 and 5, an average route length of around 250 km is assumed. For the assessment of construction- and operation-related environmental impacts, certain widths of the cable trench [m] and a certain area of the crossing structures [^{m2}] are assumed for route corridors for submarine cable systems. Above all, the construction, operation and repair-related environmental impacts are considered.

For the route corridors for pipelines, cross-border submarine cable systems or data cables, the cable lengths result from the specifications. For pipelines, a width of 1.5 m for the overlying pipeline is assumed for the assessment of environmental impacts, plus 10 m of impairments due to "reef effect" and sediment dynamics in each case.

For other uses, assessment criteria or parameters for the environmental assessment are to be developed or specified in the further procedure.

Shipping

In order to assess the environmental impacts of shipping, it is necessary to examine which additional impacts can be attributed to the stipulations in the ROP.

The designated priority areas for shipping are to be kept free of constructional use. This control in the ROP is intended to avoid or at least reduce collisions and accidents. Due to the stipulations in the ROP, the traffic frequency in the priority areas is expected to increase, whereby this is particularly due to the increase in offshore wind farms along the shipping routes. Vessel movements on the shipping routes SN1 to SN17 and SO1 to SO5 vary greatly, with over 15 vessels per km² per day in some cases on the busiest route SN1, while on the other, narrower routes it is mostly approx. 1-2 vessels per km² per day. (BfN, 2017).

The BSH has commissioned an expert report on the traffic analysis of shipping traffic, where up-to-date evaluations are expected.

The designation of only priority areas for shipping is not an expression of increased use, but rather serves to minimise risk as a precautionary measure.

The presentation of general impacts from shipping is presented in Chapter 2 as a pre-impact, especially for birds and marine mammals. The impacts from service transport to the wind farms are dealt with in the chapter on wind energy.

Raw material extraction

When assessing the potential environmental impacts of raw material extraction, a distinction must be made between sand and gravel extraction and the extraction of hydrocarbons.

Sand and gravel extraction:

Sand and gravel are extracted using floating suction dredgers. In the process, the extraction field is driven over in strips approx. 2 m wide and the subsoil is extracted to an extraction depth of approx. 2 m. The seabed remains unused between the extraction strips. Between the mining strips, the seabed remains undisturbed. During mining, a sediment-water mixture is conveyed on board the suction dredger. The sediment in the desired grain size is sieved out and the fraction that is not needed is returned to the sea on site. Turbidity plumes are created by the mining and discharge. Potential temporary impacts result from the turbidity plumes, which can lead to disturbance and scouring effects on marine fauna. Potential permanent impacts arise from the removal of substrates and physical disturbance resulting in habitat and area loss, habitat modification and seabed disturbance.

Sand and gravel extraction is carried out on the basis of operational plans on partial areas of the approved permit fields.

Gas extraction:

Exploratory or production wells are drilled to explore and develop gas deposits. Drilling through the rock above the reservoir produces drilling debris. This is brought to the surface by means of drilling fluids. The drilling fluids have either a water or oil base. If a water-based drilling fluid is used, it is discharged into the sea together with the cuttings. If oil-based drilling fluids are used, they are disposed of on land together with the cuttings.

Seismic methods are used in the exploration of hydrocarbon deposits, which lead to scaring effects on marine mammals.

Operational discharges into the sea are caused by the discharge of production water and spray water, wastewater from the sewage treatment plant and the shipping traffic generated. Production water is essentially reservoir water, which may contain components from the subsurface, such as salts, hydrocarbons and metals. The amount of gas in the production water increases with the age of the reservoir. Production water can also contain chemicals that are used in production technology to improve extraction or to prevent corrosion of production equipment. The production water is discharged into the sea after state-of-the-art treatment and compliance with national and international standards.

Fisheries and marine aquaculture

In the area of the southern mud bottom, the sediment there determines a particularly suitable habitat for this species, which can be spatially delimited quite well. The demarcation of the reserved area for Norway lobster fishing was based on an evaluation by the Thünen Institute for Sea Fisheries for the BSH, produced by an intersection of VMS data and logbook data (2012 to 2018). (Letschert & Stelzenmüller, 2020). The Norway lobster population in the North Sea is considered stable and is classified as "least concern" in the IUCN Red List. (Bell, 2015). For the German fishing fleet, the nephrops fishery represents a valuable and reliable source of income. Negative impacts of fishing in this area mainly concern the seabed, the sediment and the habitats affected thereby, which can be impaired by the trawls used.

Table 3: Parameters for the consideration of fisheries.

Fishing effort (German fleet)	Approx. 8000 hrs/year (2013) to 14,000 hrs/year (2018) 12 (2014) - 18 (2015) vehicles
Fishing gear used	Bottom trawls
Catch	200 - 350 t / year (plus non-German fisheries)

Marine research

The areas defined for marine scientific research (3 in the North Sea, 4 in the Baltic Sea) correspond to standard study areas ("boxes") of the Thünen Institute in the North Sea and the Baltic Sea. In the North Sea, data on the stock development of fish species are collected in long-term study series as part of the German Small-scale Bottom Trawl Survey (GSBTS), which has been conducted since 1987. The data sets form an important basis for assessing long-term changes in the bottom fish fauna (commercial and non-commercial species) of the North Sea and the Baltic Sea, caused by natural (e.g. climatic) influences or anthropogenic factors (e.g. fishing).

The GSBTS samples the bottomfish communities on a small scale using a standardised bottom trawl or a high accumulation otter trawl of the GOV type to record abundance and distribution patterns. In parallel, the epibenthos (by means of a 2 m beam trawl), the infauna (by van Veen grab) and sediments are investigated, and hydrographic and marine chemical parameters are recorded in regionally typical habitats.

Effects are to be expected from the equipment used, especially on the soil / sediment and the habitats affected by it. For this purpose, fish of different age and size classes are taken (cf. also chapter 5.5.3).

Table 4: Parameters for the consideration of marine research

Frequency of surveys per year/ number of hauls / duration per haul (approximate values, vary from trip to trip)	2 / in the range of approx. 40 - 50 (GSBTS only) / 30 min.
Gear used (target species)	Standardised bottom trawl catches, with high stowage otter trawl (demersal communities) 2-metre tree trawl (Epibenthos) Van Veen griffin (Infauna)
Catch	Total quantities for all (sampled) boxes (partly with other research activities) in the double-digit ton range

Nature Conservation / Seascape / Open Space

The provisions on nature conservation in the maritime spatial plan are not expected to have any significant negative environmental impacts.

The specifications help to ensure that the marine environment in the EEZ is permanently preserved and developed as an ecologically intact open space over a large area. The size of the designations, with an EEZ area share of 37.92% in the North Sea, is of particular importance in this respect. The priority areas for nature conservation contribute to safeguarding the open space, as they exclude uses that are incompatible with nature conservation. Keeping the protected areas free of construction also contributes to the protection of open space and the marine landscape on a large scale.

The designation of the main distribution area of harbour porpoises and the main concentration area of common divers as reserved areas is of outstanding importance for nature conservation in order to protect the species group of divers and harbour porpoises, which is sensitive to disturbance.

The guiding principles of careful and sparing use of natural resources in the EEZ, as well as the application of the precautionary principle and the ecosystem approach, are intended to avoid or reduce impairments to the natural balance.

The maritime spatial plan thus contributes to achieving the objectives of the MSFD. However, the influence of spatial planning is limited and cannot have an impact on all objectives.

National and alliance defence

The ROP contains textual provisions on national and alliance defence.

1.6 Data basis

The basis for the SEA is a description and assessment of the state of the environment in the study area. All protected goods are to be included. The data basis is the basis for the assessment of the likely significant environmental impacts, the site and species protection assessment and the alternatives assessment.

Pursuant to sec. 8 para. 1 sentence 3 ROG, the environmental assessment refers to what can reasonably be required according to the current state of knowledge and generally accepted test methods as well as the content and level of detail of the maritime spatial plan.

The environmental report will, on the one hand, describe and assess the current state of the environment and present the likely development if the plan is not implemented. On the other hand, it will forecast and assess the likely significant environmental effects resulting from the implementation of the plan.

The basis for the assessment of possible impacts is a detailed description and evaluation of the state of the environment. The description and assessment of the current state of the environment as well as the probable development in the event of non-implementation of the plan will be carried out with regard to the following objects of protection:

- Surface/Floor
- Water
- Plankton
- Biotope types
- Benthos
- Fish
- Marine mammals
- Avifauna
- Bats
- Biodiversity
- Air
- Climate
- Landscape
- Cultural assets and other material assets
- People, especially human health
- Interactions between protected goods.

1.6.1 Overview data basis

The data and knowledge situation has improved significantly in recent years, in particular due to the extensive data collection within the framework of environmental impact studies as well as the construction and operation monitoring for offshore wind farm projects and the accompanying ecological research.

This information also forms an essential basis for the monitoring of the 2009 maritime spatial plans in accordance with Article 45(4) UVPG. According to this, the results of the monitoring must be made available to the public and taken into account when the plan is drawn up again. Results of the plan-accompanying monitoring of the current plans are summarised in the status report on the update of spatial planning in the German EEZ in the North Sea and Baltic Sea published in parallel (Chapter 2.5).
In generalised summary, the following data bases are used for the environmental report:

- Data and findings from the operation of offshore wind farms
- Data and findings from approval procedures for offshore wind farms, submarine cable systems and pipelines
- Results from the preliminary land use study
- Results from the monitoring of Natura 2000 sites

- Mapping instructions for sec. 30 biotope types
- MSFD Initial and Progress Assessment
- Findings and results from R&D projects commissioned by the BfN and/or the BSH and from accompanying ecological research
- Results from EU cooperation projects, such as Pan Baltic Scope and SEANSE
- Studies/ Technical literature
- Current Red Lists
- Comments from the specialist authorities
- Comments from the (specialist) public

A detailed overview of the individual data and knowledge bases is included in the appendix of the study framework.

1.6.2 Indications of difficulties in compiling the documents

According to No. 3a Annex 1 to sec. 8 para. 1 ROG, indications of difficulties encountered in compiling the information, for example technical gaps or lack of knowledge, must be presented. In some places there are still gaps in knowledge, particularly with regard to the following points:

- Long-term effects from the operation of offshore wind farms
- Effects of shipping on individual protected goods
- Effects of research activities
- Data for assessing the environmental status of the various protected goods for the area of the outer EEZ.

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

In particular, there is no 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 impacts of the possible use of strictly protected biotope structures. Currently, a sediment and biotope mapping with a spatial focus on the nature conservation areas is being carried out on behalf of the BfN and in cooperation with the BSH, research and university institutions and an environmental agency.

In addition, scientific assessment criteria are lacking for some protected goods, 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 effects both temporally and spatially.

Various R&D studies on assessment approaches, including for underwater noise, are currently being prepared on behalf of the BSH. The projects serve the continuous further development of a uniform, quality-tested basis of marine environmental information for the assessment of possible impacts of offshore installations.

The environmental report will also list specific information gaps or difficulties in compiling the documents for the individual protected goods.

1.7 Application of the ecosystem approach

The application of the ecosystem approach can contribute to achieving the guiding principle of sustainable spatial development pursuant to sec. 1 para. 2 ROG, which reconciles the social and economic demands on space with its ecological functions and leads to a permanent, large-scale balanced order. Its application is a requirement under sec. 2 para. 3 no. 6 sentence

9 ROG with the aim of guiding human activity, sustainable development and supporting sustainable growth (cf. Art. 5(1) MSP Directive in conjunction with Art. 1(3) of the Marine Strategy Framework Directive).

Recital 14 of the MSP Directive specifies that spatial planning should be based on an ecosystem approach in accordance with the MSFD. Likewise, it is made clear here - as in preamble 8 of the MSFD - that the sustainable development and use of the seas must be compatible with good environmental status.

According to Art. 5(1) of the MSP Directive, Member States shall "take into account economic, social and environmental aspects in the preparation and implementation of maritime spatial planning [...] in order to support sustainable development and growth in the marine area, applying an ecosystem approach, and to promote the coexistence of relevant activities and uses".

Art. 1 para. 3 MSFD specifies that "marine strategies shall apply an ecosystem approach to the management of human activities that ensures that the overall impact of such activities is limited to a level compatible with the achievement of good environmental status and that the capacity of marine ecosystems to respond to human-induced change is not compromised, while allowing for the sustainable use of marine goods and services now and by future generations".

The ecosystem approach enables a holistic view of the marine environment, recognising that humans are an integral part of the natural system. Natural ecosystems and their services are considered with the interactions of their uses. The approach is to manage ecosystems within the 'limits of their functioning' to safeguard them for use by future generations. Furthermore, understanding ecosystems enables effective and sustainable use of resources.

A comprehensive understanding, protection and enhancement of the marine environment, as well as effective and sustainable use of resources within carrying capacity limits, safeguard marine ecosystems for future generations. The ecosystem approach can therefore contribute - at least in part - to a good state of the marine environment.

Based on the so-called twelve Malawi principles of the Biodiversity Convention, the ecosystem approach has also been concretised and specified for marine spatial planning by the HELCOM-VASAB working group on maritime spatial planning (HELCOM/VASAB, 2016). The key elements formulated there represent a suitable approach for structuring the application of the ecosystem approach in the spatial plan for the German EEZ.

The combination of content-related and process-oriented key elements should promote the most comprehensive overall picture possible:

- Use of the current state of knowledge;
- Precautionary principle;
- Examination of alternatives;
- Identification of ecosystem services;
- Avoidance and mitigation of impacts;
- Understanding of contexts;
- Participation and communication;
- Subsidiarity and coherence;
- Adaptation.

The application of the ecosystem approach aims at a holistic perspective, the continuous development of knowledge about the oceans and their use, the application of the precautionary principle and flexible, adaptive management or planning. One of the biggest challenges is dealing with knowledge gaps. Understanding the cumulative effects that the combination of different activities can have on species and habitats is of great importance for sustainable use. It is important for the planning process to promote communication and participation processes in order to be able to use the broadest possible knowledge base of all stakeholders as well as to achieve the greatest possible acceptance of the plan.

Figure 12shows the understanding of the application of the ecosystem approach. This takes place equally in the planning process, in the ROP and in the Strategic Environmental Assessment (SEA). The SEA proves to be the central instrument for applying the ecosystem approach. (Altvater, 2019) and offers a wide range of links to the key elements in terms of content and process.

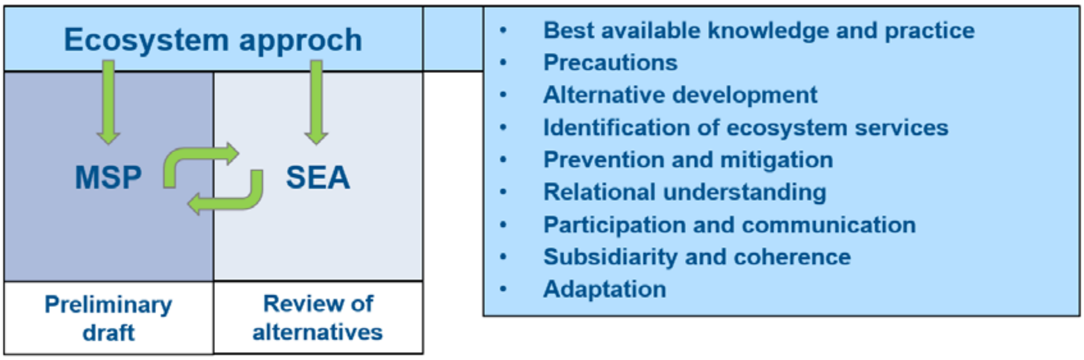


Figure 12: The ecosystem approach as a structuring concept in the planning process, the ROP and the Strategic Environmental Assessments

The ecosystem approach is anchored in the mission statement as the basis of the maritime spatial plan. In addition, its importance is explicitly highlighted in the following principles:

- Principles on general requirements for economic uses: Avoidance of harm to the marine environment and best environmental practice (4.1) and monitoring (4.2);
- Principle on offshore wind energy: protection of the marine environment (6);
- Nature conservation principles: bird migration (5) and preservation of the EEZ as a natural area (6)

The spatial and textual specifications for marine nature conservation fundamentally contribute to the protection and improvement of the state of the marine environment (see ROP vision). In addition, the provisions of the ROP promote the resilience of the marine environment - against impacts from economic uses and against changes caused by climate change.

A quantification of the carrying capacity of the ecosystem cannot be considered conclusively due to a lack of data and knowledge. This is a task for the future development of the ecosystem approach. Even if quantification is not possible at present, the SEA and cumulative consideration of impacts ensure that the ROP, with its stipulations on economic uses, does not exceed the limits of ecosystem functioning.

The assessment of the likely significant environmental impacts of the implementation of the maritime spatial plan are methodologically described in Chapter 1.5.2The ecosystem approach does not itself constitute an assessment, but it encompasses a large number of important aspects and instruments for sustainable spatial development. The SEA comprehensively serves to identify, describe and assess the impacts on the marine environment.

Application of the key elements

The ecosystem approach is highly complex due to its versatility and comprehensive consideration of the relationships between the marine environment and economic uses. The key elements also interact with each other, which underlines the interconnectedness and holistic perspective. Figure 13shows abstractly the relationships between the key elements. This approach becomes tangible and applicable through consideration at the level of the individual key elements, here in particular those of the HELCOM/VASAB Guideline (2016).

The application in the spatial plan for the German EEZ follows the understanding that this approach is to be constantly further developed. Existing knowledge gaps and the need for conceptual broadening result in the necessity to consider the ecosystem approach as a permanent task of further development.

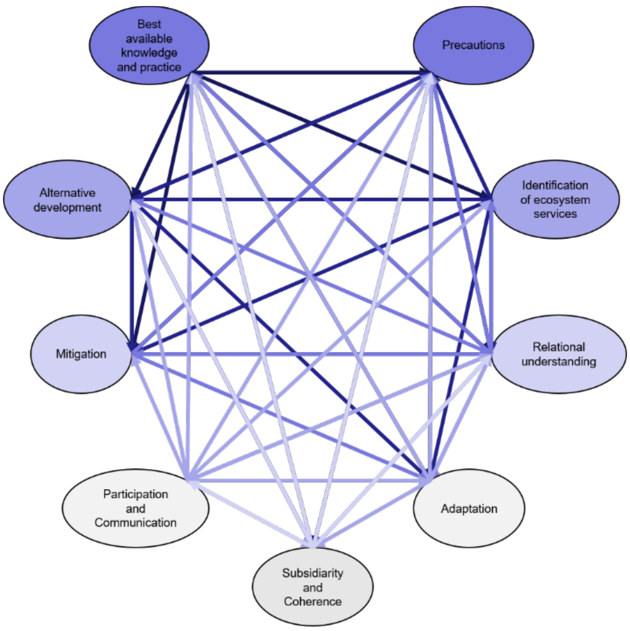


Figure 1314: Networking between the key elements

Use of the current state of knowledge

"Allocation and development of human uses shall be based on the latest knowledge of ecosystems as such and the practice of best protection of the components of the marine ecosystem". (HELCOM/VASAB, 2016).

The use of the current (well-founded) state of knowledge is fundamentally indispensable for planning processes and the basis of the planning understanding for updating maritime spatial plans. This key element thus also affects the other elements mentioned, such as the precautionary principle, the avoidance and mitigation of impacts and the understanding of interrelationships.

In the context of the update process, the knowledge base is supplemented by the sector-specific expertise of the stakeholders through an early and comprehensive participation process. Thematic workshops and expert discussions were held with various stakeholders even before the concept for the update was drawn up.

The Scientific Advisory Group (WiBeK) on the update of maritime spatial planning in the EEZ in the North Sea and Baltic Sea provides scientific advice on issues such as content, the procedure and the participation process.

Results from international cooperation projects and findings on the approach to plan preparation of neighbouring countries are taken into account for the plan preparation process. In addition to improving knowledge, this contributes to the key element of "subsidiarity and coherence".

In-house research and developments, such as databases and other analysis tools, are developed, validated and used at the BSH for a wide range of applications, e.g. MARLIN and MarineEARS. These can support the planning process and subsequent plan monitoring with well-founded information and make an important contribution to the continuous improvement of the state of knowledge.

The following stipulations of the maritime spatial plan promote the use of the current state of knowledge in economic uses as a basic requirement:

- Principle on shipping: sustainability, protection of the marine environment (4);
- Principles on general requirements for economic uses: Best Environmental Practice (4.1) and Monitoring (4.2);
- Principle on offshore wind energy: protection of the marine environment (6);
- Principle on marine research: sustainability, protection of the marine environment (3).

The SEA is based on very detailed and comprehensive data on all relevant biological and physical aspects and conditions of the marine environment, in particular from environmental impact studies and monitoring of offshore wind farm projects according to StUK, scientific research activities and from national and international monitoring programmes.

Precautionary principle

"Far-sighted, anticipatory and preventive planning should promote sustainable use in marine areas and eliminate risks and threats to the marine ecosystem from human activities. Those activities which, on the basis of current scientific knowledge, may lead to significant or irreversible impacts on the marine ecosystem, and the effects of which, in whole or in part, may not be sufficiently foreseeable at present, require particularly careful study and weighting of risks." (HELCOM/VASAB, 2016).

The precautionary principle has a high priority in spatial planning, particularly due to the complexity of marine ecosystems, far-reaching chains of effects and existing gaps in knowledge. This is already emphasised in the ROP's mission statement.

The provisions of the maritime spatial plan clarify the consideration of the precautionary principle in economic uses as a fundamental requirement (Principle 6 Nature Conservation / Marine Landscape / Open Space) as well as in the following uses:

- Objective on navigation: Priority areas for navigation (1);
- Objective on general requirements for economic uses: Deconstruction (2);
- Principles on general requirements for economic uses: Sustainability, land conservation (1) and avoidance of harm to the marine environment and best environmental practice (4.1);
- Principle on offshore wind energy: protection of the marine environment (6);
- Principles on pipelines: Minimisation of Impacts (5) and Marine Environment (6);
- Principle on nature conservation: Preservation of the EEZ as a natural area (6).

The SEA examines the significance of the impacts of the ROP provisions on uses on the protected goods (Section 4).

Examination of alternatives

"Reasonable alternatives should be developed to find solutions to avoid or reduce negative impacts on the environment and other sectors, as well as on ecosystem goods and services". (HELCOM/VASAB, 2016).

The development and examination of alternatives was given high priority in the process of updating the maritime spatial plans and alternative planning options were publicly consulted even before the first draft of the plan. The early and comprehensive consideration of several planning options represents an essential planning and examination step in the updating of the maritime spatial plans. In the concept for the further development of the maritime spatial plans (BSH, 2020) three planning options were developed as overall spatial planning alternatives, which represent the utilisation requirements of the sectors from different perspectives:

- Planning option A: Perspective Traditional uses
- Planning option B: Climate protection perspective
- Planning option C: Perspective on marine nature conservation

The alternatives presented as planning options are integrated approaches that take into account the spatial and contextual interdependencies and interactions on a large scale.

A preliminary assessment of selected environmental aspects was already carried out for the concept before the preparation of this environmental report. This preliminary assessment allowed a comparison of the three planning options from an environmental perspective in the sense of an early assessment of variants and alternatives.

The conceptual design and the preliminary assessment of selected environmental aspects were consulted so that the knowledge and assessment of the stakeholders involved on the planning options could be incorporated into the planning process at an early stage.

An assessment of alternatives to the ROP takes place in the SEA (cf. chapter 9). The focus is on the conceptual, strategic design of the plan, and in particular on spatial alternatives.

Identification of ecosystem services

"To ensure a socio-economic assessment of impacts and potentials, the ecosystem services provided need to be identified" (HELCOM/VASAB, 2016).

The identification of ecosystem services is an important step for the further development of the spatial plan and the ecosystem approach in maritime spatial planning. Ecosystem services can contribute to a more comprehensive understanding, as they can clarify the multiple functions of ecosystems. In the case of marine ecosystems, the function as natural carbon sinks and other contributions to climate protection and adaptation should be highlighted in particular. This consideration should be taken into account in future updates of the maritime spatial plan and the development of the necessary tools should be continued.

With the MARLIN (Marine Life Investigator) application, the BSH is currently developing a large-scale and high-resolution information network on marine ecological data from environmental investigations in the context of environmental impact studies, preliminary site investigations and monitoring of offshore wind farm projects. Various data analyses at different spatial and temporal levels are possible in order to support the BSH's tasks as required. MARLIN also combines the integrated marine ecological data with various environmental data and thus supports the understanding of impacts and interrelationships of marine ecosystem services.

In the future, MARLIN will serve as a validated basis for ecosystem modelling to better assess the impact of cumulative effects. For example, it will be possible in future to consider all offshore wind farm procedures and to create large-scale studies. Based on this, an identification of ecosystem services can begin. MARLIN's holistic approach enables new approaches to the analysis and modelling of ecological patterns and processes and creates a platform for the development and application of advanced tools for marine spatial planning.

Avoidance and mitigation of impacts

"Measures are provided to prevent, reduce and offset as fully as possible any significant adverse effects [of the implementation of the plan] on the environment." (HELCOM/VASAB, 2016).

The ROP's guiding principle defines the contribution to the protection and improvement of the state of the marine environment also by stipulating the prevention or reduction of disturbance and pollution.

The provisions of the maritime spatial plan clarify this consideration with measures for the avoidance and mitigation of negative impacts for individual uses:

- Principle on shipping: sustainability, protection of the marine environment (4);
- Principle on general requirements for economic uses: Best Environmental Practice (4.1);
- Principle on offshore wind energy: protection of the marine environment (6);
- Principles on pipelines: Minimisation of Impacts (5) and Marine Environment (6);
- Raw material extraction principle: divers (2);

- Principle on marine research: sustainability, protection of the marine environment (3);
- Nature conservation objective: Priority areas for nature conservation and priority area for divers (1);
- Principles of nature conservation: seasonal reserved area for harbour porpoise (3), bird migration corridors (5) and safeguarding and preserving the seascape (8).

In the SEA, measures to avoid, reduce and compensate for significant negative impacts of the implementation of the maritime spatial plan are comprehensively presented in Chapter 8

Understanding of interrelationships

"It is necessary to consider various impacts on the ecosystem caused by human activities and interactions between human activities and the ecosystem and between different human activities. These include direct/indirect, cumulative, short/long-term, permanent/temporary and positive/negative impacts and interactions, including sea-land interactions." (HELCOM/VASAB, 2016).

Understanding interconnections and interrelationships is of high importance for the planning process and the tasks of spatial planning. In this sense, the guiding principle of the ROP emphasises the holistic view and includes the consideration of land-sea relationships.

This is addressed and examined in the Strategic Environmental Assessment in chapters 4.10Interactions and 4.11Cumulative Consideration.

Here, too, reference can be made to the current development of the MARLIN (Marine Life Investigator) specialist application at the BSH, which supports the understanding of impacts and interrelationships.

Further experience, e.g. on cumulative consideration, was gained in European cooperation projects (Pan Baltic Scope, SEANSE) and is incorporated into the conceptual development just as much as findings from the participation process.

An overview of the project results can be found on the respective pages:

- http://www.panbalticscope.eu/results/reports/
- https://northseaportal.eu/downloads/

Participation and communication

"All relevant authorities and stakeholders as well as a wider public are to be involved in the planning process at an early stage. The results shall be communicated." (HELCOM/VASAB, 2016).

This key element exemplifies the interconnectedness and relationships of the key elements. The knowledge gained can contribute to all other key elements.

Within the framework of the update process, participation and communication have been carried out intensively from the beginning. The early and comprehensive participation was able to significantly expand the knowledge base through the sector-specific expertise of the stakeholders and through the assessments received in comments.

The starting point for this was the development of a participation and communication concept. In the course of the update, topic-specific workshops and expert discussions were held at sectoral level. On 18 and 19 March 2020, the concept with the planning options and the draft of the assessment framework were consulted in the participation meeting (scoping).

Interim results and information on stakeholder meetings are communicated on the BSH blog "Offshore aktuell" (https://wp.bsh.de).

Additional support for the process is provided by the Scientific Advisory Group (WiBeK). The WiBeK on the update of maritime spatial planning in the Exclusive Economic Zone in the North Sea and Baltic Sea has been providing advice from a scientific perspective since 2018, among other things with regard to substantive issues as well as the course of the procedure and the participation process.

Subsidiarity and coherence

"Maritime spatial planning, with an ecosystem-based approach as the overarching principle, is carried out at the most appropriate level and strives for coherence between the different levels" (HELCOM/VASAB, 2016).

Spatial planning aims to create coherent plans in the North Sea and Baltic Sea through coordination with the coastal federal states and neighbouring states. Many years of bilateral exchange, participation in the HELCOM and VASAB working group on maritime spatial planning and cooperation in international projects on maritime spatial planning contribute to this.

Project results and findings on neighbouring countries' plan preparation procedures in the context of international cooperation are taken into account in the plan preparation process. A further contribution is made by the international consultation procedures.

The ROP's mission statement sets out this co-operation as a contribution to coherent international marine spatial planning and coordinated planning with coastal countries.

At the level of specifications, the following objectives and principles highlight the need for co-ordination in planning cross-border structures:

- Objectives for navigation: Priority areas for navigation (1) and temporary priority area for navigation (2);
- Target to be piped: Coastal Sea Boundary Corridors (3);
- Principle on pipelines: Suitable transition points at the territorial sea and border corridors to adjacent states (4);
- Nature conservation principle: Bird migration corridors (5).

Within the framework of the SEA, the transboundary impacts for the adjacent areas of the neighbouring states are considered (Section 4.12).

Adaptation

"Sustainable use of the ecosystem should be an iterative process that includes monitoring, review and evaluation of both the process and the outcome" (HELCOM/VASAB, 2016).

Monitoring and evaluation in the context of spatial planning for the German EEZ take place at different levels.

First, the plan and its implementation will be evaluated. A monitoring and evaluation concept will be developed for this purpose.

In addition, the planned measures for monitoring the effects of the implementation of the maritime spatial plan on the environment are listed in Chapter 10part of the SEA.

The mission statement already stipulates a situation-specific adaptation of the provisions for all sectoral concerns as an ongoing evaluation process, with the involvement of the competent federal ministries.

Effects of economic uses on the marine environment should be investigated and evaluated at project level by means of effect monitoring. This is stipulated in Principle 4.2 of the general requirements for economic uses in the ROP.

Summary

In sum and beyond, the key elements and their implementation in the planning process, the ROP as well as the SEA show how the ecosystem approach as an overall concept supports the holistic perspective of spatial planning and thus contributes to the protection and improvement of the state of the marine environment.

1.8 Consideration of climate change

Anthropogenic climate change as one of the greatest societal challenges is of particular importance for changes in the seas and their use. Figure 15the interrelationships between climate change, the marine ecosystem, uses and maritime spatial planning, also as an instrument for achieving the Sustainable Development Goals.

In changing seas, the consideration and integration of climate impacts into MSP is of great importance in order to do justice to the precautionary and future-oriented nature of MSP and to develop plans that are sustainable in the long term.

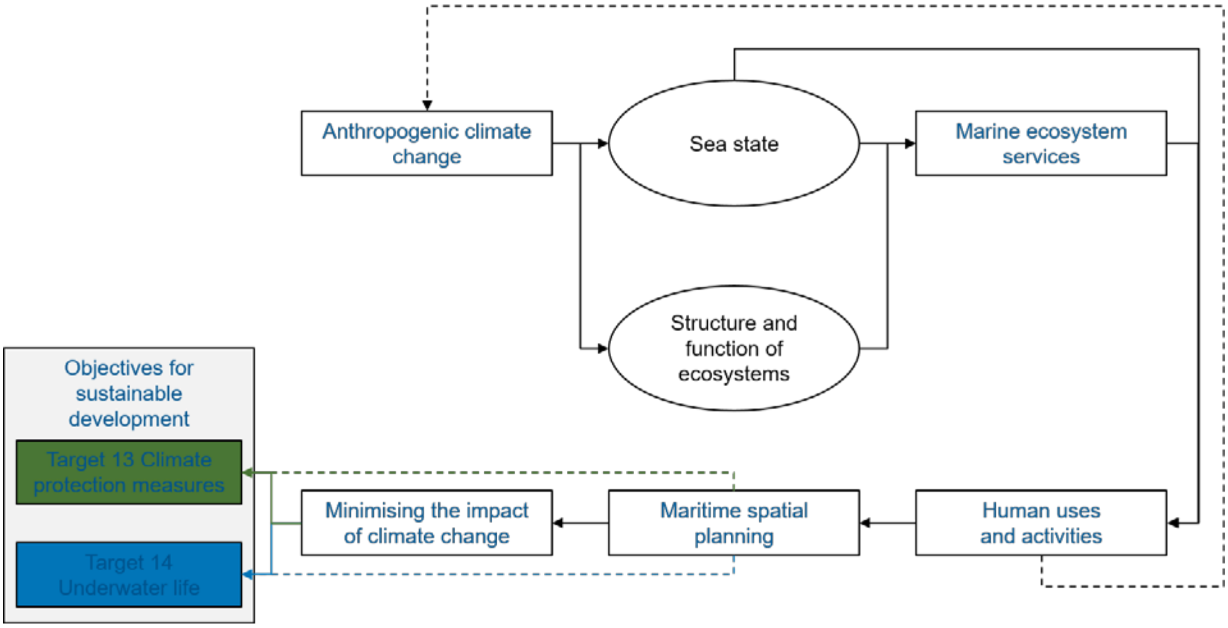


Figure 15: Illustration of the interrelationships of climate change, marine ecosystems and maritime spatial planning, according to (Frazão Santos, 2020)

Climate change will alter the physical, chemical and biological conditions in the North and Baltic Seas. This will inevitably have an impact on marine ecosystems, their structure and functions, which may also change ecosystem services. The changes may also have a direct impact on uses, e.g. for shipping, renewable energy or raw material extraction. (Frazão Santos, 2020).

The following table shows projections of some relevant parameters.

Table 5: Climate projections for selected parameters [1] (UBA, in Vorbereitung), [2] (IPCC, 2019), [3] (Schade N, 2020)

	North Sea	Baltic Sea
Increase in mean sea surface temperature for 2031-2060 (in the 50th percentile of the RCP8.5 scenario compared to 1971-2000)[1]	1 – 1,5 °C	1,5 – 2 °C
Increase in mean sea surface temperature for 2071-2100 (in the 50th percentile of the RCP8.5 scenario compared to 1971-2000)[1]	2,5 – 3 °C	2,5 – 3,5 °C
Global sea level rise 2100 (RCP8.5 scenario vs. 1986-2005)[2]	61 - 110cm	61 - 110cm
Increase in extreme wind speeds (RCP8.5 scenario compared to 1971-2000)[3]	0 - 0.5 m/s	No majority significant increases west of the Stralsund-Trelleborg line; east of it 0-0.5 m/s

As a contribution to climate protection, the provisions on offshore wind energy should be mentioned first and foremost. Assuming that the current CO2 avoidance factor for electricity from offshore wind energy is extrapolated to the year 2040, this results in a CO2 avoidance potential of (UBA, 2019) to the year 2040, this results in a CO2 avoidance potential of 62.9 Mt CO2 equivalents per year on average for the period between 2020 and 2040. By way of comparison, annual emissions from power plants in the energy industry in 2016 were 294.5 Mt CO2 equivalents per year. (BMU, 2019).

Table 6 accordingly presents the abatement potential for the years 2020, 2040 and the annual average for the entire period.

Table 6: Calculation of the CO2 avoidance potential of the provisions on offshore wind energy

	installed capacity	Full load hours	Annual electricity production	CO2 avoidance factor	CO2 avoidance
	GW	h/a	GWh/a	g CO2eq/kWh	Mt CO2eq/a
2020	7,2	3800	27360	701	19,2
2040	40	3800	152000	701	106,6
Average CO2 avoidance per year					62,9

Furthermore, keeping nature conservation priority areas free and the potential of ecosystems as natural carbon sinks contributes to climate protection. The designation of priority and reserved areas for nature conservation can also contribute to strengthening the resilience of ecosystems and thus support the precautionary principle.

The mission statement shows that the use of climate-friendly technologies in the ocean supports energy security and the achievement of national and international climate goals.

The development of risk and vulnerability analyses for climate change and adaptation measures in the relevant sectors should be communicated to spatial planning. The holistic perspective of spatial planning can help to coordinate the compatibility of measures with other uses and marine nature conservation and to avoid conflicts. In order to promote this, a dialogue could be initiated that a joint discussion takes place in a forum of spatial planning with stakeholders from the sectors.

For the comprehensive inclusion of climate change in MSP, it is necessary to strengthen institutional cooperation, including international cooperation in the North and Baltic Seas. Projects in particular offer the opportunity to develop coherent approaches with neighbouring countries or to use joint data pools, for example.

One focus should be the conceptual development of marine ecosystem services and especially the potential of natural carbon sinks.

2 Description and assessment of the state of the environment

According to Section 8 ROG in conjunction with. Annex 1 and 2 to Section 8 ROG, the environmental report contains a description of the characteristics of the environment and the current state of the environment in the SEA study area. The description of the current state of the environment is necessary in order to be able to forecast its change upon implementation of the plan. The subject of the inventory are the protected goods listed in 8 (1) ROG as well as interactions between them. The presentation is problem-oriented. Emphasis is therefore placed on possible existing pressures, environmental elements that are particularly worthy of protection, and on those protected assets that will be more strongly affected by the implementation of the plan. In spatial terms, the description of the environment is based on the respective environmental impacts of the plan. These vary in extent depending on the type of impact and the protected property concerned, and may extend beyond the boundaries of the plan.

2.1 Area

The German EEZ in the North Sea and Baltic Sea is of great importance for many uses and for the marine environment. At the same time, its area is limited, so land-saving use is imperative. Land sparing is therefore also reflected in the guidelines and principles of the maritime spatial plan, as a result of which the protected resource of land is of particular importance in the ROP, both in principle and across all uses.

One guiding principle of spatial planning is the sustainable development of space (cf. sec. 1 para. 2 ROG). The basis for this sustainable development of the limited resource of land in the EEZ of the North Sea and Baltic Sea is the most efficient and sparing use of land, especially in the case of competing uses. This can lead to a situation where the ROP does not always specify the desirable area for uses, but rather the sufficient area. Therefore, the spatial planning process, under the premise of land economy and in consideration of the various protection and use interests, is in itself a treatment of land as an object of protection.

A synopsis of all the designations in the plan, may give the impression that hardly any, if any, area in the German EEZ remains unused. On the one hand, the designation of an area for a particular use does not necessarily mean that 100 % of this area will be used for that use. Secondly, not all uses take place at the same time or over the entire period. Spatial planning in the sea has a three-dimensional space at its disposal, which can lead to an overlapping of uses on one area, as in the case of the uses of pipelines and shipping, for example. Even uses that actually take up space in the sense of land do not necessarily take up 100% of it. An example of this is the use of wind energy at sea. The actual land consumption by wind turbines and platforms (incl. scour protection) as well as cabling within the park amounts to less than 0.5 % of the areas defined for offshore wind energy.

Another aspect of sustainable and economical use of land resources is the obligation to dismantle structures, submarine cables, etc. after the end of their operating life, so that these areas are available for subsequent use.

2.2 Soil

2.2.1 Data situation

An important basis for the description of the surface sediments of the North Sea EEZ is the map of sediment distribution in the German North Sea, at a scale of 1:250,000 (LAURER et. al, 2014; Project GPDN - Geopotential German North Sea, Figure 16). This map was initially only available for the German Bight and was updated with the GPDN project and the map by Laurer et al. 2014 and extended to cover the entire German EEZ of the North Sea. Like the previous version, the mapping is based on point distributed grain size distributions from surface soil samples, which were classified according to the sediment classification system of Figge (1981) and interpolated into the area. As part of the AWZ sediment mapping project, area-wide sediment mapping using hydroacoustic methods has been carried out for several years (BSH, 2016). In addition to the larger scale of 1:10,000, the applied methodology offers the advantage that spatial interpolation of selectively distributed samples is no longer necessary. The resulting detailed maps improve the knowledge of small-scale structural and sedimentary changes on the seabed surface enormously (Figure 18a/b). In particular, existing knowledge gaps regarding the distribution of coarse sand-fine gravel surfaces and residual sediments in the form of gravel, stones and boulders (Figure 18c) can be closed as a result. Thus they also form a valuable data basis for detailed biotope mapping. The maps are not yet available for the entire North Sea EEZ, but the protected areas are largely covered (see Figure 16and www.geoseaportal.de).

The descriptions of the structure of the near-surface subsoil are mainly based on boreholes, pressure soundings and reports of subsoil investigations, from projects such as "Shelf Geo-Explorer Baugrund" (SGE-Baugrund) and the GPDN project, the literature and the BSH's own investigations and evaluations.

The data and information used to describe the distribution of pollutants in the sediment, suspended solids and turbidity, and nutrient and pollutant distribution are collected during the BSH's annual monitoring cruises.

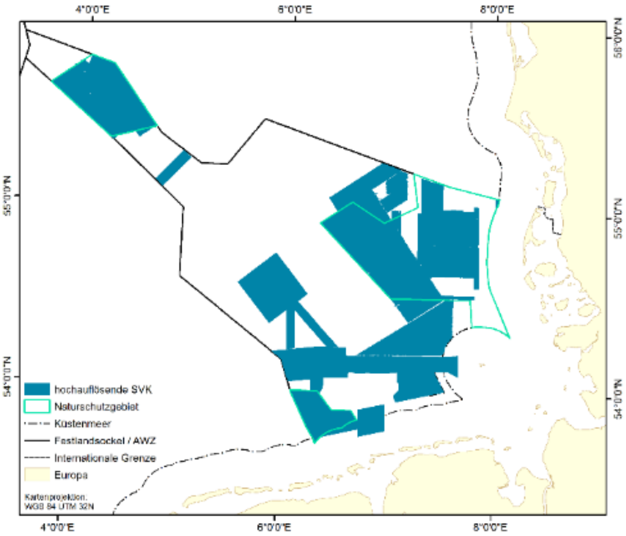


Figure 1617: Detailed sediment distribution maps scale 1 : 10,000 (current data availability)

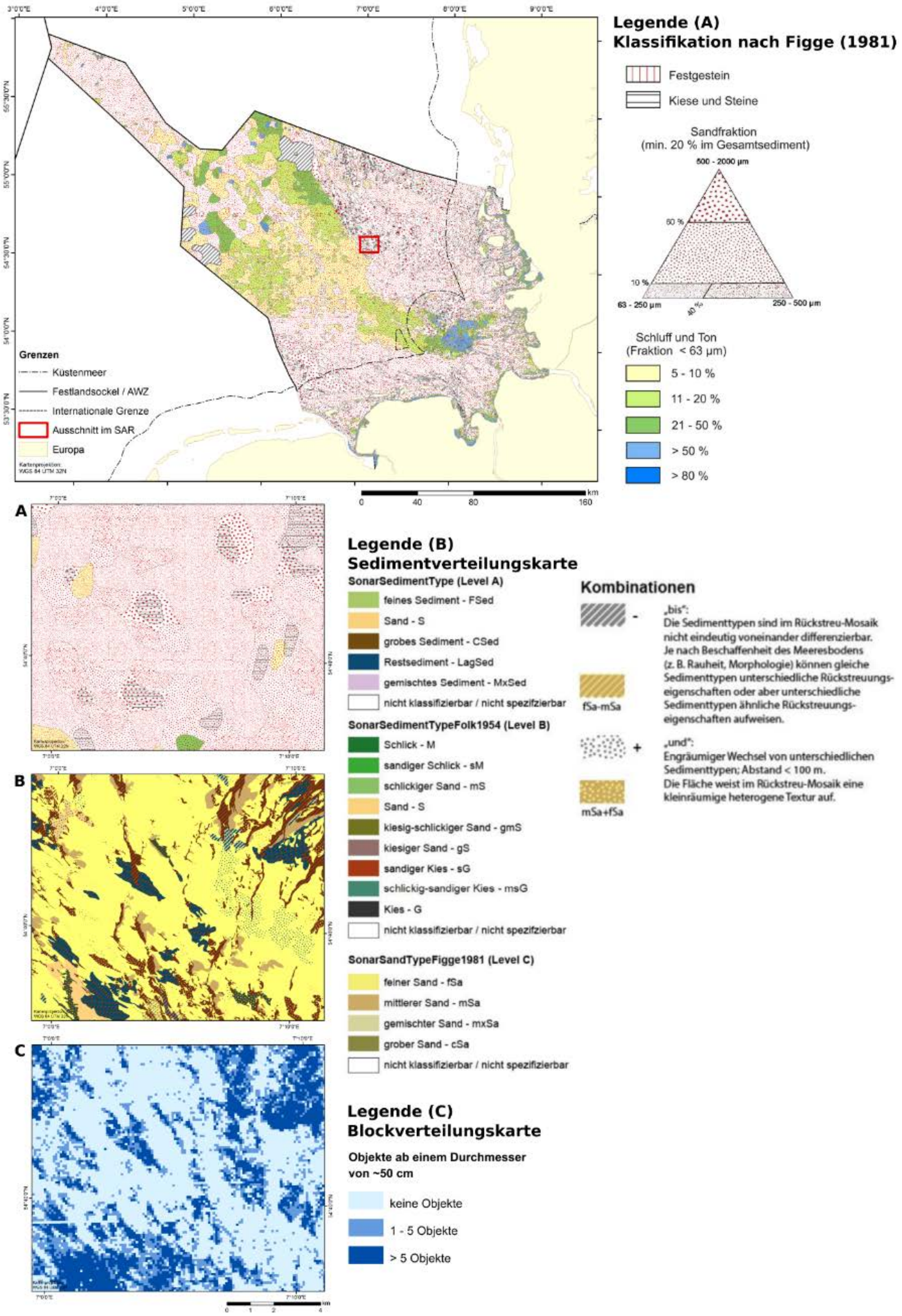


Figure 18: a/b) Comparison of interpolated and areal sediment distribution maps. c) Block distribution map

2.2.2 Geomorphology and sedimentology

The planning area under consideration - the German EEZ of the North Sea - extends from the seaward boundary of the coastal seas of Lower Saxony and Schleswig-Holstein to the so-called "Entenschnabel" (duck's bill), the elongated extension in the extreme northwest of the German EEZ that extends into the central North Sea. The bathymetry of this area can be seen in Figure 19

The former Elbe glacial valley divides the North Sea EEZ into a western and an eastern subarea, resulting in a regional geological division into 4 regions (Figure 19):

- Borkum and Norderney Reef Ground (1),
- North of Heligoland (2),
- Elbe glacial valley and western plains (3),
- Dogger and Northern Shill Bank (4).

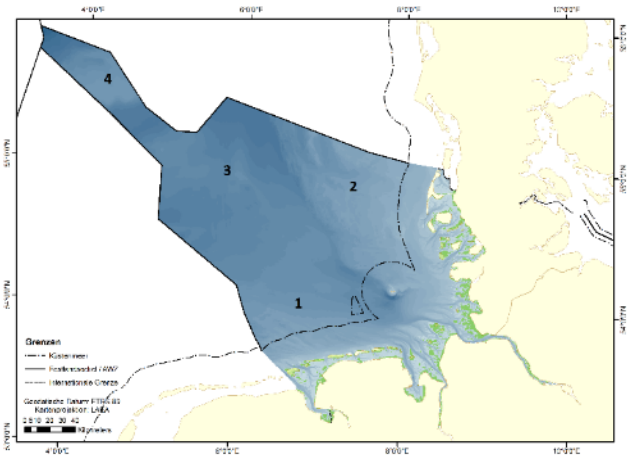


Figure 19: Bathymetry in the EEZ and regional geological classification

Borkum and Norderney Reef Ground

This sub-area comprises the area of the Borkum and Norderney reef bottom between the two traffic separation areas "GermanBight Western Approach" and "Terschelling German Bight" and borders the 12 nautical mile limit off Helgoland in the east.

The seabed slopes evenly from 18 m in the southwest to 42 m in the north and 36 m in the east. Along the 12-nautical-mile boundary to the coastal sea of Lower Saxony, the foothills of the shoreface connected sand ridges as defined by REINECK (1984) protrude into the EEZ. They run in a northwest-southeast direction and are subject to pronounced sediment dynamics. Their core remains largely stable, while their top layer is subject to horizontal positional changes of between 100 and 200 m per year (ANTIA, 1996). In small areas, ripple fields of various shapes are observed on the sandy areas, which indicate recent sediment transport or sand rearrangement.

The sediment distribution on the seabed in the area of the Borkum and Norderney reef bottoms is predominantly heterogeneous. Here, medium to coarse sandy sediments are found in particular, with gravel to a lesser extent. Stones can occur in the entire area of the reef bottoms. The new findings from the area-wide sediment mapping show a widespread occurrence of stones, boulders and erratic blocks in the Borkum Riffgrund. Towards the north-east or east and with increasing water depth, the sediments change into medium to fine sands, whose proportion of silt and clay reaches up to 10% in places and can rise to 20% in the area of the former Elbe glacial valley (Laurer et al, 2014).

Holocene and Pleistocene sedimentary layers can be identified in the subsoil near the surface. Beneath a 0.5 to 2.5 m thick cover layer of North Sea sands (Nieuw Zeelandgronden Formation) lie periglacial fine sands of the late Weichselian period, which in places contain clay layers and stones (Twente Formation) and can reach thicknesses of up to 16 m. In the area of the reef bottoms, both formations wedge out; there are reworked ground moraine deposits from the Saale. In the area of the reef bottoms, both formations wedge out; there, reworked ground moraine deposits from the Saale glacial period are present under a coarse sandy to gravelly residual sediment cover on the seabed. The sandy-clayey boulder clay, which can locally carry erratic blocks or stones, is deposited on Eemian marine sands consisting of a sandy sedimentary sequence from the late Elster and early Holstein periods, which can reach several metres in thickness. In the respective horizons, former gullies or depressions are encountered, whose fill material can have a heterogeneous sediment composition ranging from silt and clay to gravel. In some layers, peat is also to be expected. The gullies meander in the subsoil, but are spatially confined according to previous findings.

North of Heligoland

This sub-area extends from the 12-mile limit off North Friesland seawards to the eastern shore of the former Elbe glacial valley and ends in the north at the EEZ border with Denmark.

The water depths range from 9 m at the western edge of the Amrum Bank to 50 m in the northwest of the sub-area. Morphologically, the western part in particular is characterised by a very uneven relief for conditions in the German Bight. Particularly noteworthy are the prominent submarine geest edge along the Elbe glacial valley, the western edge of the Amrum Bank and the ridges in the northern area, which extend from the Danish shelf into the German EEZ. Characteristic form inventory are large or mega ripple fields, coarse sand strips and erosion furrows, the formation of which is closely related to sediment supply, grain size composition and hydrodynamic forces (DIESING et al., 2006). In addition, biogenic structures such as mussel fields are observed in sonograms (side-scan sonar recordings) (WERNER, 2004).

The sub-basin is characterised by a pronounced heterogeneous sediment distribution on the seabed. In addition to fine and medium sands, coarse sands and gravels are also common. The proportion of fine grains rarely exceeds 5% (Laurer et al, 2014). Pleistocene uplands were worked up and partially levelled during sea-level rise. They have the characteristic cover of residual or relict sediments (coarse sands, gravels, boulders and erratics). Between these residual sediment deposits, fine to medium sand surfaces occur, which are usually 0.5 to 2 m thick, but may be missing in places. In exceptional cases, the boulder clay within these residual sediment fields is directly attached to the seabed. In contrast to the Borkum and Norderney reef bottoms, a higher density of stones can be observed on the seabed in this sea area, which are concentrated in northwest-southeast oriented structures (SCHWARZER and DIESING, 2003).

The current results of the area-wide sediment mapping show extensive areas of stony residual sediments and boulders on the seabed surface, especially east of the former Elbe glacial valley (cfFigure 18a-c).

The structure of the upper seabed is essentially shaped by the glacial advance of the Saale period (Warthe stage). The subsoil is traversed to varying degrees by filled meltwater channels and depressions. According to the data available so far, the main drainage of this glacial gully system can be assumed to be NW to W. In addition to clastic water, the glaciers are also found in the gullies. In addition to clastic sediments such as sands, clays, silts and gravels, organogenic sediments such as peat also occur in these structures.

Elbe glacial valley and western plains

This sub-area extends northwest of Helgoland to the German-Danish and German-Dutch EEZ borders, but excludes the area of the so-called Duck's Bill. In the east, the eastern shore of the former Elbe glacial valley, which forms a striking

Geestkante appears on the seabed, the boundary to the sub-area "Nördlich Helgoland". This area north of the traffic separation areas has water depths between about 30 m and 50 m and slopes slightly from the southeast to the west and north. In the centre of the sub-area is the White Bank, which rises about 3 m from the surrounding seabed. The seabed in this sub-area has a very even relief and is largely flat. Occasionally, side-scan sonar images indicate depression-like formations, in which the content of finer-grained material usually increases. Ripple fields occur in places, probably due to bottom currents. The seabed surface consists of fine sands with notable contents of silt and clay. In the area of the Elbe glacial valley, the recent surface sediment shows an increase in clay and silt content of up to 50% correlating with the water depth. The fine sands show good to very good grading. Occasional small-scale gravel deposits may occur locally. In the plains to the west of the former Elbe glacial valley, stone deposits are also to be expected to a small extent.

The determining element in the subsurface is the Elbe glacial valley located in the eastern part of the area, which runs northwest or north along the submarine geest edge bordering it to the west. This valley, which used to be approx. 30 km wide, was initially filled with an alternating layer of fine sandy and silty clay sediments in the course of the Holocene marine transgression, and later predominantly with sandy sediments. The thickness of the sediment fill reaches approx. 20 m. In the area of the adjacent plains to the west, however, thicknesses of 1 m are exceeded only in exceptional cases. Below this, mostly densely bedded fine to medium sands with coarse sand intercalations follow. They may contain gravel and gravel layers, occasionally also clays, silts or peat.

Dogger and Northern Shill Bank

This area includes the area of the so-called "duckbill", the elongated extension in the extreme north-west of the EEZ, which lies in the area of the central North Sea and extends to the EEZ borders of Denmark, Great Britain and the Netherlands.

The seabed morphology is determined by the Dogger Bank, whose north-eastern extension, the tail's end, crosses the sub-basin as a submarine ridge. The shallowest water depths of 29 m are found on the Dogger Bank, while the greatest depths of 69 m are measured on its north-western flank. Distinctive bottom forms such as sand waves or large or megaripple fields, as encountered on the British side, have not been observed in this subarea. The seabed is generally relatively poor in structure.

Sedimentologically, the seabed surface consists predominantly of a very well sorted fine sand cover which is occasionally interrupted by patchy occurrences of silt and clay admixtures or coarse sand sediments.

The Dogger Bank contains a Pleistocene core of Weichselian sediments (Dogger Bank Formation), which underlies Holocene North Sea sands up to about 15 m thick. The Dogger Bank Formation consists of stiff to very stiff silty clay that locally carries gravels and stones and can reach a thickness of several tens of metres. The sediments of the Dogger Bank Formation probably extend to the south-eastern boundary of the Duck's Bill. Late Weichselian gullies filled with soft silty clays occur in their area. In the north-western slope area of the Dogger Bank, the Holocene sand layer thins out or is completely missing in places. Between the Dogger Bank and the northern shingle bank, periglacial fine sands with a thickness of 2 to 16 m occur, which may locally contain clay layers and stones. These lie on the marine fine sands from the Eemian warm period, which can be traced through the entire sub-area with thicknesses of between 2 and 16 m. The sandy layers are also present.

2.2.3 Pollutant distribution in the sediment

Metals

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

Especially the elements copper, cadmium and nickel are at low levels or in the range of background concentrations in most regions of the German EEZ. All heavy metals show elevated levels near the coast, less pronounced along the East Frisian Islands than along the North Frisian coast. These very clear 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 addition, there are possible inputs of metals from maritime shipping and the offshore industry (e.g. from corrosion protection measures), whose additional contribution cannot be estimated at present. Specifically, lead in particular also shows significantly increased levels in the fine grain fraction in the central North Sea. These are even higher than the values measured at stations near the coast. The spatial distribution of nickel contents in the fine-grain fraction of the surface sediment, on the other hand, is only characterised by very weakly pronounced gradients. The spatial structure hardly allows any conclusions to be drawn about pollution hotspots. Although the values for Pb and Hg in the latest MSFD report (State of the German North Sea Waters 2018) are still above the threshold values, in general the heavy metal load in the surface sediment of the EEZ has tended to decline over the past 30 years (Cd, Cu, Hg) or has no clear trend (Ni, Pb, Zn).

Organic substances

The majority of organic pollutants are of anthropogenic origin. About 2,000 mainly industrially produced substances are currently considered environmentally relevant (pollutants) because they are toxic (toxic) or persistent in the environment (persistent) and/or can accumulate in the food chain (bioaccumulative). Since their properties can vary greatly, their distribution in the marine environment depends on a variety of factors. In addition to input sources, input quantities and input pathways (directly via rivers, offshore industry or diffusely via the atmosphere), the physical and chemical properties of the pollutants and the dynamic-thermodynamic state of the sea are relevant for dispersion, mixing and distribution processes. For these reasons, the various organic pollutants in the sea show an uneven and varying distribution and occur in very different concentrations.

The BSH determines up to 120 different pollutants in seawater, suspended matter and sediments during its monitoring cruises. For most pollutants in the German Bight, the Elbe is the main source of input. Therefore, the highest pollutant concentrations are generally found in the Elbe plume off the North Frisian coast, which generally decrease from the coast to the open sea. Here, the gradients for non-polar substances are particularly strong, as these substances are predominantly adsorbed on suspended matter and removed from the water phase by sedimentation. Outside the coastal regions rich in suspended matter, the concentrations of non-polar pollutants are therefore usually very low. However, many of these substances are also carried into the sea by atmospheric deposition or have direct sources in the sea (such as PAHs (polycyclic aromatic hydrocarbons), which can be carried in by the oil and gas industry and shipping. Therefore, land-based sources must also be considered in the distribution of these substances.

According to current knowledge, the observed concentrations of most pollutants in the sediment of the German EEZ do not pose an immediate risk to the marine ecosystem. PAHs are below the OSPAR threshold values in the German EEZ in the North Sea. Only PCB-118 does not currently meet the criteria (State of the German North Sea Waters 2018).

Radioactive substances (radionuclides)

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

Contaminated sites

Ammunition remnants are a possible contaminated site in the North Sea. In 2011, a federal-state working group published a basic report on the ammunition contamination of German marine waters, which is updated annually. According to official estimates, 1.6 million tonnes of old ammunition and various types of ordnance are stored on the seabed of the North Sea and the Baltic Sea. A significant part of these munitions legacies originate from the Second World War. Even after the end of the war, large quantities of ammunition were dumped in the North and Baltic Seas to disarm Germany. According to current knowledge, the explosive ordnance load in the German North Sea, especially in the territorial sea, is estimated at up to 1.3 million tonnes. The overall data situation is insufficient, so that it can be assumed that explosive ordnance deposits are also to be expected in the area of the German EEZ (e.g. remnants of mine barrages and combat operations). For the only known munitions dumping area in the North Sea EEZ (approx. 15 nautical miles west of Sylt), there is little and unclear information on the type and quantity of conventional munitions dumped.

In principle, the ammunition remnants can silting up or be exposed on the seabed if the sediment properties are appropriate. In addition, storm events or strong currents can lead to ammunition bodies in the sediment being exposed. Ammunition bodies can thus represent artificial hard substrates.

Current research results indicate that the state of corrosion of ammunition stored in the sea may be advanced. Whether and to what extent the marine environment is affected by the release of toxic substances (e.g. explosives such as TNT) is the subject of current research and part of the work to implement the resolutions of the 93rd Conference of Environment Ministers, agenda item 27.

The location of the known munitions dumping areas can be found on the official nautical charts and in the 2011 report (which also includes suspected areas for munitions-contaminated areas). The reports of the Federal-Länder Working Group are available at www.munition-im-meer.de. Information on munitions finds, including the EEZ, is also provided by the OSPAR Commission at https://odims.ospar.org/.

2.2.4 Assessment of the status of soil as an object of protection

2.2.4.1 Rarity and endangerment

The aspect "rarity and vulnerability" takes into account the areal proportion of sediments on the seabed and the distribution of the morphological form inventory throughout the North Sea. The sediment types and bottom forms in the plan area are found throughout the North Sea. Thus, the aspect "rarity and endangerment" is assessed as "low".

2.2.4.2 Diversity and Eigenart

The aspect "diversity and uniqueness" considers the heterogeneity of the described surface sediments and the expression of the morphological form inventory.

The sediment composition of the surface sediments in the plan area is quite heterogeneous. In addition to the widespread fine sands, medium and coarse sands are also frequently found. Residual sediments, gravels and stones also occur. In the area of the Borkum and Norderney reef bottoms as well as north of Helgoland, special morphological forms such as tongue reefs and large and megaripple fields occur. A pronounced geest edge forms the border to the Elbe glacial valley.

The aspect "diversity and distinctiveness" is rated "medium".

2.2.4.3 Preload

Natural factors

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

Tectonic and isostatic movements, earthquakes: the tectonic and isostatic processes are secular processes, i.e. they cover periods of several millennia. They have their causes in the plate tectonic movements of the earth's crust and therefore run over a large area. The analysis of earthquake frequency and magnitude for the North Sea makes it clear that the German EEZ is not an earthquake-prone area. However, there is evidence that about 8,000 years ago a seaquake triggered the submarine Storegga landslide in the Norwegian Sea, which subsequently generated a tsunami wave that spread throughout the North Sea.

Anthropogenic factors

Eutrophication: as a result of anthropogenic inputs of nitrogen and phosphorus via rivers, the atmosphere and diffuse sources, increased primary production leads to increased sedimentation of organic matter. This is largely degraded by microbial activity in the water column or on the seabed surface, so that its contribution to the sediment composition (grain size distribution) can be neglected.

Fisheries: In the North Sea, otter trawls and beam trawls are used in bottom trawling. Otter trawls are mainly used in the northern North Sea and are pulled diagonally across the seabed. Their roller harness avoids snagging on rocks, which can, however, be turned over when driven over. Beam trawls have been used mainly in the southern North Sea since the 1930s. Since the 1960s there has been a large increase in beam trawling, which has declined slightly in the last decade due to catch regulations and the decline in fish stocks. The skids of beam trawls leave 30 to 50 cm wide tracks. Especially their scouring chains or chain nets have a stronger effect on the bottom than otter trawls. In the sediment, the bottom trawls create specific furrows that can be a few millimetres to 8 cm deep on boulder clay and sandy soils and up to 30 cm deep in soft silt (PASCHEN et al., 2000). In addition, the use of bottom trawls results in a smoothing of the seabed by levelling ripple structures or smaller bottom elevations. The distribution of time spent on international trawl activities in the North Sea shows a regional variation in fishing effort with a concentration in the southern part. In purely arithmetical terms, in a heavily fished area 100% of the area is swept by a beam trawl about 4 ×times per year, whereas in less fished areas only 2% of the area is affected. In reality, fishing takes place on already "cleaned" routes, so that some sub-areas are fished several times a year, others only occasionally within several years (RUMOHR, 2003).

Sand and gravel extraction: In the North Sea EEZ, gravel sands and sands are extracted over large areas using a suction trailer hopper dredging method, usually resulting in the formation of dm-deep furrows. With a maximum excavation depth of 2.5 m (including dredging tolerance), a residual thickness of recoverable sediment must be preserved to maintain the original substrate for recolonisation. In the case of backfilling the extraction structures, finer-grained sediments usually provide the filling material (ZEILER et al., 2004). In the subfields currently being exploited in the EEZ, the extraction of gravel sand deposits is selective, i.e. only the sandy or gravelly sediment fraction is extracted and the corresponding residual fraction is returned to the seabed. On the one hand, this selective extraction results in a coarsening or refinement of the sediments on the seabed in the extraction fields; on the other hand, a furrow- or trough-shaped relief remains to a certain extent because the recent hydro- and sediment-dynamic processes in the EEZ cannot lead to a complete refilling with the original sediment due to the sediment supply. Sand and gravel extraction produces turbidity plumes to varying degrees, which, depending on the proportion of silt and clay, predominantly sediment again on the seabed surface within a radius of approx. 500 m around the extraction site.

Wind turbines*: The* construction of wind turbines and the associated scour protection leads - in addition to temporary sediment resuspension - to long-term small-scale sealing of the seabed.

Submarine cables (telecommunication, energy transmission): Due to the wash-in process during cable laying in the seabed, turbidity of the water column occurs as a result of sediment resuspension, which, however, is distributed over a larger area due to the influence of tidal currents. In the process, the suspension content decreases again to the natural background values due to dilution effects and sedimentation of the whirled-up sediment particles. As a rule, the sediment dynamic processes lead to a complete levelling of the laying tracks, especially after periods of bad weather. In the area of cable crossings, riprap is applied, which represents a locally limited off-site hard substrate.

Natural gas production: Natural gas has been produced in the NW corner of the Duck's Bill since 2000. So far, there are no indications of subsidence phenomena in the vicinity of the production facility "A6-A", as described in the area of facilities on the Dutch or Norwegian continental shelf of the North Sea (e.g. FLUIT and HULSCHER, 2002; MES, 1990). For the former natural gas deposit "Ekofisk", a total subsidence of up to 6 m is expected (SULAK and DANIELSEN, 1989). It cannot be ruled out that seabed subsidence will occur in the vicinity of the A6-A platform after several years of production. This will depend on the geological conditions in the subsurface and will essentially be limited to the area of the deposit (approx. 15 km²).

Shipping: In the event of an anchor being dropped, the seabed is stirred up locally to a maximum depth of 1 m, depending on the size of the anchor and the type of sediment. Depending on the water depth, type and amount of sediment present, wrecks can become silted up and exposed again. Depending on their size, they influence the small-scale sediment dynamics by causing scouring in the near vicinity or sedimentation of sands in the current shadow.

Anthropogenic factors affect the seabed in the following ways:

- Abtrag
- Intermixing
- Resuspension
- Material sorting
- Sealing
- Displacement and
- Compaction.

In this way, the sediment structure, the natural sediment dynamics (sedimentation/erosion) and the mass transfer between sediment and soil water are influenced.

The extent of anthropogenic preloading of the sediments and the morphological form inventory is decisive for the assessment of the aspect "preloading". With regard to the criterion "prior pollution", the soil as a protected resource is assigned a medium level of pollution, since the aforementioned prior pollution is present, but does 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 to the north. The oceanic climate of the North Sea - characterised by salinity and temperature - is largely determined by this northern opening to the Atlantic. In the southwest, the Atlantic has less influence on the North Sea due to the shallow English Channel and the narrow Dover Strait.

2.3.1 Currents

The currents in the North Sea consist of a superposition of the semi-diurnal tidal currents with the wind- and density-driven currents. In general, a large-scale cyclonic, i.e. counterclockwise, circulation prevails in the North Sea, associated with a strong inflow of Atlantic water at the northwestern margin and an outflow into the Atlantic over the Norwegian Channel. 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 or the German Hydrographic Institute (DHI) between the years 1957 and 2001 (KLEIN 2002), the mean amounts of current velocity (scalar mean including tidal current) and the residual current velocities (vector mean) near the surface (3 - 12 m water depth) and near the bottom (0 - 5 m bottom distance) were determined for different areas in the German Bight (Table 7). 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 7tidal currents were determined by connecting to the Helgoland tide gauge, i.e. the measured currents are related to the tidal ranges and high tide times observed there (KLEIN & MITTELSTAEDT 2001).

Table 7: Mean current velocities, residual and tidal currents in the German Bight.

	Surface proximity (3 – 12 m)	**Ground level (0 - 5 m ground clearance)**
Average amount	25 - 56 cm/s	16 - 42 cm/s
Vector means (residual current)	1 - 6 cm/s	1 - 3 cm/s
Tidal stream	36 - 86 cm/s	26 - 73 cm/s

Figure 20 shows the flow conditions in the near-surface layer (3 - 12 m measurement depth) for different areas in the German Bight. In the representation, the values in area GB3 correspond to the (geological) sub-area "Borkum and Norderney Reef Ground", GB2 corresponds to the sub-area "North of Helgoland" and GB1 corresponds to the sub-area "Elbe Urstromtal and Western Plains".

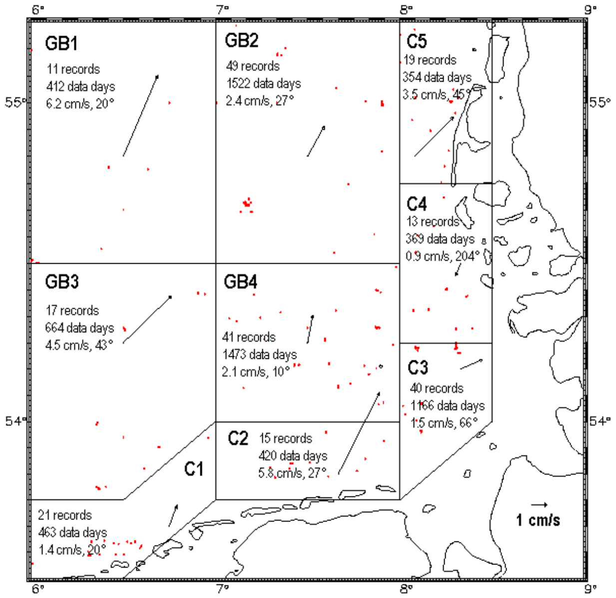


Figure 20: Vector means of the flow in the near-surface layer (measurement depth 3 to 12 m). The measurement positions are marked with a red dot (BSH 2002).

2.3.2 Sea state

In the case of swell, a distinction is made between waves generated by the local wind, the so-called wind sea, and swell. Swells are waves that have left their area of origin and enter the sea area under consideration. Swell entering the southern North Sea is generated by storms in the North Atlantic or the northern North Sea. The swell has a larger 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 (effective period), as well as on the wind strike length (fetch), i.e. the distance over which the wind acts. For example, the fetch length in the German Bight is significantly shorter for easterly and southerly winds than for northerly and westerly winds. The significant or characteristic wave height is given as a measure of the wind sea, i.e. the average wave height of the upper third of the wave height distribution.

In the climatological annual 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, only to drop rapidly thereafter and remain 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 means can be transferred to the height of the swell. For the inner German Bight, the directional distribution of the swell for the unmanned lightship UFS German Bight (formerly UFS Deutsche Bucht) shows - analogous to the distribution of the wind direction - a distribution with a maximum for swell from the west-southwest and a second maximum from the east-southeast (LOEWE et al. 2003).

2.3.3 Temperature, salinity and seasonal stratification

Water temperature and salinity in the German EEZ are determined by large-scale atmospheric and oceanographic circulation patterns, freshwater inputs 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 temperature minimum in the German Bight usually occurs at the end of February/beginning of March, the seasonal warming begins 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) find extreme values of 3.5 °C in February and 17.8 °C in August for the period 1968-2015. This corresponds to a mean 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 insolation, thermal stratification sets in between the end of March and the beginning of May in the northwestern German Bight at water depths of more than 25-30 m. The temperature in the northwest of the Bay of Biscay is higher than in the northwest of the Bay of Biscay. When stratification is pronounced, vertical gradients of up to 3 K/m are measured in the temperature jump layer (thermocline) between the warm surface 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 usually mixed even in summer as a result of turbulent tidal currents and wind-induced turbulence. With the onset of the first autumn storms, the German Bight is thermally vertically mixed again.

The time series of the annual means of the spatial mean temperature of the entire North Sea based on the temperature maps published weekly by the BSH since 1968 shows that the course of the SST is not characterised by the linear trend, but by regime changes between warmer and colder phases (see also Fig. 3-28 in BSH 2005). The extreme warm regime of the first decade of the new millennium, in which the annual mean of North Sea SST fluctuated around a mean level of 10.8 °C, ended with the cold winter of 2010 (Figure 22). After four significantly cooler years, the North Sea SST reached its highest annual mean of 11.4 °C so far in 2014.

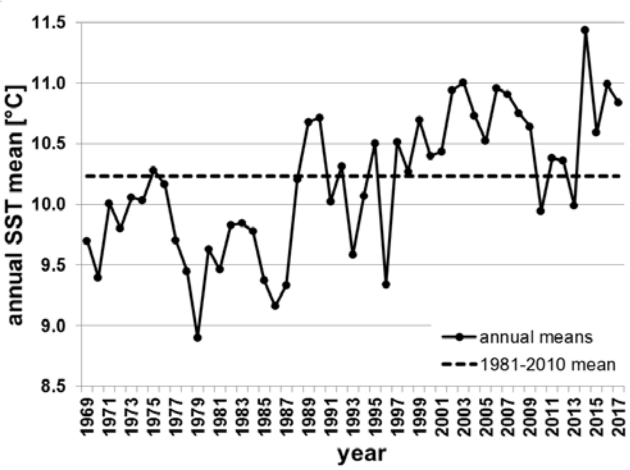


Figure 21: Annual mean North Sea surface temperature for the years 1969-2017

With regard to climate-related changes, QUANTE et al. (2016) expect an increase in SST of 1-3 K by the end of the century. Despite considerable differences in the model simulations with regard to setup, forcing from the global climate model, bias corrections, etc., the different projections arrive at consistent results (KLEIN et al. 2018).

In contrast to temperature, salinity does not have a distinct 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. Here, the freshwater runoff from the large rivers mixes with the coastal water within the estuaries due to tidal turbulence at shallow water depths, but stratifies over the North Sea water at greater depths in the German Bight. The intensity of the stratification varies depending on the annual variation of river inputs, which in turn show considerable inter-annual variability, e.g. as a result of high meltwater discharges in spring after heavy snow winters. For example, the salinity at Helgoland Reede is negatively correlated with the discharge volumes of the Elbe, which shows that freshwater inputs cause a significantly reduced near-surface salinity near the coast (LOEWE et al. 2013), whereby the Elbe, with a discharge of 21.9 km³/year, has the strongest influence on salinity in the German Bight.

Salinity measurements from Helgoland Reede have been available since 1873, and since about 1980 also the data at the positions of the former lightships, which were later at least partially replaced by automated measuring systems. The relocation of lightship positions and methodological problems, also with the measurements at Helgoland, led to breaks and uncertainties in the long time series and made reliable trend estimates difficult (HEYEN & Dippner 1998). For the annual means of surface salinity at Helgoland, no long-term trend is apparent for the years 1950-2014. This also applies to the annual discharge rates of the Elbe. The projections for the future development of salinity in the German EEZ currently still differ greatly in terms of temporal development and spatial patterns; more recent projections indicate a decrease in salinity of between 0.2 and 0.7 PSU by the end of the century (KLEIN et al. 2018).

2.3.4 Ice conditions

In the open German Bight, the heat reserve of the relatively salty North Sea water is often still so large in early winter that ice can only very rarely form. 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 as far as directly behind the islands and into the outer estuaries of the Elbe and Weser. In normal winters, ice occurs in the North Frisian tidal flats in the sheltered inner fairways on 17 to 23 days, in the open fairways - similar to the East Frisian tidal flats - only on 2 to 5 days.

In the North Frisian tidal flats, on the other hand, ice occurs on average on 54 to 64 days in the sheltered inner fairways in winters with plenty of ice and on 31 to 42 days in the open fairways, similar to the East Frisian tidal flats. In the inner tidal flats, mainly fast ice forms. In the outer tidal flats, mainly floe ice and ice mush 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).

2.3.5 Fronts

Fronts in the ocean are high-energy mesoscale structures (scale from a few 10 to a few 100 km) that have major impacts on local water movement dynamics, biology and ecology and - through their ability to carry CO2 to greater depths - also on 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 sediment gradients lie between the area of freshwater inputs from the large continental rivers and the continental coastal waters of the North Sea. These fronts are not static entities, but consist of a system of smaller fronts and eddies with typical spatial scales between 5 and 20 km. This system is subject to great temporal variability with time scales from 1 to about 10 days. Depending on the meteorological conditions, the discharge rates of the Elbe and Weser and the circulation conditions in the German Bight, frontal structures continuously dissolve and form. Only under extremely calm weather conditions can discrete frontal structures be observed over longer periods of time. Approximately in the area of the 30 m depth line, the tidal mixing fronts are located during the period of seasonal stratification (approx. from the end of March to September), which mark the transition area between the thermally stratified deep water of the open North Sea and the shallower area that is vertically mixed as a result of 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 produced a climatology for SST, chlorophyll, yellow and suspended sediment fronts in the North Sea. This shows that fronts occur 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 the adjacent areas play a key role in the marine ecosystem. They influence ecosystem components at all levels, either directly or as a cascading process through the food chain (ICES 2006). Vertical transports on fronts bring nutrients into the euphotic zone and thus increase biological productivity. The increased biological activity at fronts due to the high availability and effective utilisation of nutrients causes an increased binding of atmospheric CO2 and transport to deeper layers. The outflow of these CO2-enriched water masses into the open ocean is called "shelf sea pumping" and is an essential process for the uptake of atmospheric $_{CO2}$ by the world ocean. The North Sea is a CO2 sink in large parts all year round, with the exception of the southern areas in the summer months. The North Sea exports over 90% of the $_{CO2}$ absorbed from the atmosphere to the North Atlantic.

2.3.6 Suspended solids and turbidity

The term "suspended matter" is understood to mean all particles with a diameter >0.4 µm suspended in seawater. Suspended matter consists of mineral and/or organic material. The organic suspended matter content is strongly dependent on the season. The highest values occur during plankton blooms in early summer. During stormy weather conditions and the resulting high sea state, the suspended sediment content in the entire water column rises sharply due to silty-sandy bottom sediments being stirred up. This is where the swell has the strongest effect. When hurricane-force lows pass through the German Bight, increases in suspended sediment content of up to ten times the normal values are easily possible. It is not possible to take water samples during extreme storm conditions, so corresponding estimates come from the records of anchored turbidity measuring devices. If the temporal variability of the suspended sediment content at a fixed position is considered, a pronounced half-day tidal signal is always found. Ebb and flood currents transport the water in the German Bight on average about 10 nautical miles from and towards the coast. Accordingly, the high suspended matter content near the coast (SPM = Suspended Particular Matter) is also transported 'back and forth' and causes the strong local fluctuations. Further variability in SPM is caused by material transport (advection) from rivers such as the Elbe and Weser and from the English south-east coast.

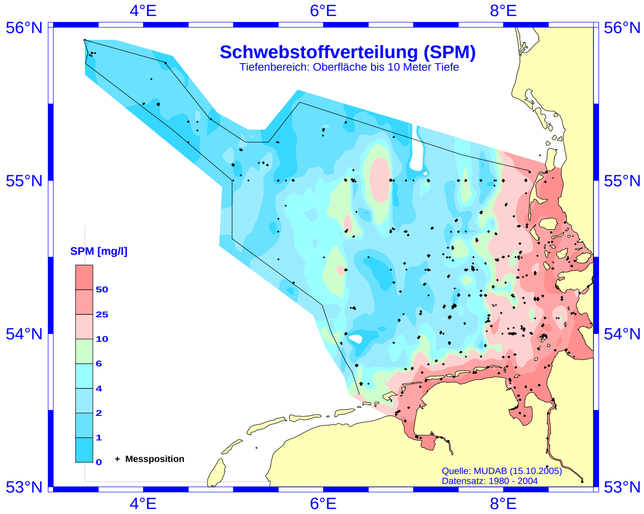


Figure 22: Mean suspended sediment distribution (SPM) for the German North Sea.

Figure 23shows a mean suspended sediment distribution for the German Bight. The basis for the representation are all SPM values stored in the Marine Environmental Database (MUDAB) as of 15.10.2005. The data set was reduced to the range "surface to 10 metres depth" and to values ≤ 150 mg/l. The underlying measured values were only obtained during weather conditions in which research vessels are still able to operate. Difficult weather conditions are therefore not reflected in the mean values shown here. Figure 23shows mean values around 50 mg/l and extreme values >150 mg/l in the tidal flat areas landward of the East and North Frisian Islands and in the large estuaries. Further seaward, the values decrease rapidly to a range between 1 and 4 mg/l. Just east of 6° E there is an area of elevated suspended sediment. The lowest SPM mean values around 1.5 mg/l are found in the north-western edge of the EEZ and over the sandy areas between the Borkum reef bottom and the Elbe glacial valley.

2.3.7 Status assessment with regard to nutrient and pollutant distribution

2.3.7.1 Nutrients

Nutrient salts such as phosphate and inorganic nitrogen compounds (nitrate, nitrite, ammonium) as well as silicate are of fundamental importance for life in the sea. They are vital substances for the build-up of phytoplankton (the microscopic unicellular algae floating in the sea), on whose biomass production the entire marine food chain is based. Since these trace substances promote growth, they are called nutrients. An excess of these nutrients, which occurred due to extremely high nutrient inputs caused by industry, traffic and agriculture in the 1970s and 1980s, leads to a strong accumulation of nutrients in the seawater and thus to overfertilisation (eutrophication). This continues today in the coastal regions. As a result, there may be an increased occurrence of algal blooms (phytoplankton and green algae), reduced visibility depths, a decline in seagrass meadows, shifts in the species spectrum and oxygen deficiency situations near the bottom.

To monitor nutrients and oxygen levels in the German Bight, the BSH carries out several monitoring cruises a year. Nutrient concentrations show a typical annual pattern, with high concentrations in winter and low concentrations in the summer months. All nutrients show similar distribution structures. A gradual decrease in concentration can be observed from the estuary towards the open sea. The highest concentrations are measured in the Elbe inflow area and in the coastal regions. The nutrient input from the Elbe is clearly visible here (Figure 25).

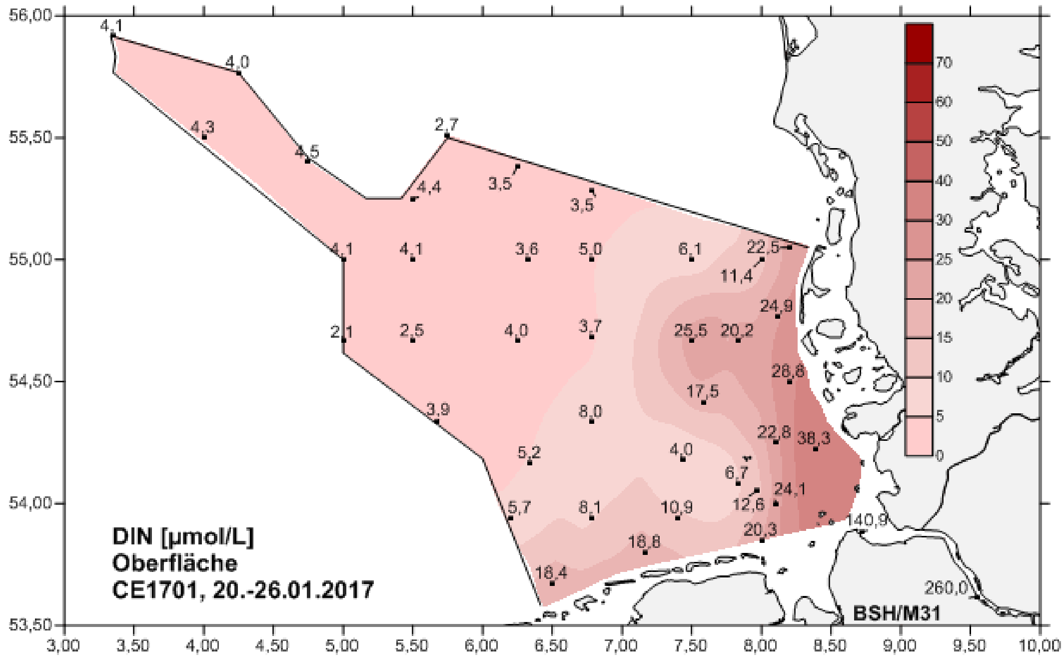


Figure 23: Distribution pattern of soluble inorganic nitrogen compounds (DIN).

Due to measures such as the expansion of sewage treatment plants, the introduction of phosphate-free detergents, etc., nutrient inputs into the North Sea have been reduced by around 50% since 1983, and phosphorus inputs by as much as around 65% (UBA 2017). Nevertheless, according to the eutrophication assessment under the OSPAR Common Procedure, the coastal waters and large parts of the German EEZ (a total of 55% of the German North Sea waters) are classified as eutrophic in the assessment period 2006-2014 (Brockmann et al. 2017). Only in the outer German Bight (Entenschnabel) could good environmental status be established (6% of German North Sea waters). This assessment serves as the basis for the subsequent assessment according to the EU MSFD, so that good environmental status continues to be missed with regard to descriptor 5 (eutrophication) also according to the MSFD (BMU 2018).

2.3.7.2 Metals

Metals occur naturally in the environment. The detection of metals in the environment is therefore by no means necessarily to be regarded as pollution. In addition to the naturally occurring element contents, human activities mobilise, transport, partially transform and re-enrich sometimes considerable additional quantities of individual elements in the environment. In general, the metal contents of seawater are determined by the structure, dynamics and strength of the sources, the large-scale circulation of marine water masses and the efficiency of their sink processes. Major sources of the anthropogenic metal signal in marine ecosystems are the runoff of contaminated freshwater masses via the continental river systems, the transport of pollutants via the atmosphere and the interaction with sediment. Further inputs are caused by offshore activities, such as raw material exploration and extraction as well as dumping of dredged material.

Metals are dissolved and bound to suspended matter in the water body. With increasing distance from the coast, i.e. with increasing salinity, the suspended matter content in the water column decreases. Thus, the proportion of the surface available for adsorption processes decreases and a proportionally increasing part of the metal content remains in solution.

Similar to nutrients, some metals in the dissolved fraction show seasonal periodic fluctuations in concentration. This seasonal profile roughly corresponds to the biological growth and remineralisation cycle, which is also relevant for the nutrient content dissolved in seawater.

Mainly dissolved elements (Cu, Ni, Cd), but also mercury, form a clearly pronounced gradient that decreases from the coast to the open sea. As a rule, the current transports the water masses into the German Bight from the west and out of it to the north. Accordingly, the discharge plume of the Elbe, starting from the estuary area, is clearly pronounced towards the north.

2.3.7.3 Organic substances

The BSH currently determines up to 120 different pollutants in seawater, suspended matter and sediments as part of its monitoring cruises. Since the Elbe is the main source of most pollutants for the German Bight, the highest pollutant concentrations are generally found in the Elbe plume off the North Frisian coast, which generally decrease towards the open sea. The gradients for non-polar substances are particularly strong, as these substances are predominantly adsorbed (attached) to suspended matter and removed from the water phase by sedimentation. Outside the coastal regions rich in suspended matter, the concentrations of non-polar pollutants are therefore usually very low. The pollution of water by petroleum hydrocarbons is low, although numerous acute oil spills from shipping can be detected by visible oil films. Most hydrocarbons originate from biogenic sources; only occasionally are traces of acute oil pollution observed in the water phase.

Through new analytical methods, a large number of "new" pollutants (emerging pollutants) with polar properties have been detected in the environment in recent years. Many of these substances (e.g. the herbicides isoproturon, diuron and atrazine) occur in much higher concentrations than the classic pollutants.

According to current knowledge, the observed concentrations of most pollutants in seawater do not pose a direct threat to the marine ecosystem. An exception is the contamination by tributyltin (TBT), which was formerly used in marine paints and whose concentration near the coast sometimes reaches the biological impact threshold. Furthermore, seabirds and seals can be harmed by oil films floating on the water surface as a result of acute oil pollution. In the ecotoxicological assessment, the toxicity of individual pollutants is not sufficient; rather, the cumulative effect of the large number of pollutants present must be considered, which may be intensified by synergy effects.

2.3.7.4 Radioactive substances (radionuclides)

For decades, radioactive contamination of the North Sea was determined by discharges from nuclear fuel reprocessing plants. Since these discharges are very low nowadays, the radioactive load of the North Sea water body does not pose a danger to humans and nature according to current knowledge.

2.4 Plankton

Plankton includes all organisms that float in the water. These mostly very small organisms form a fundamental component of the marine ecosystem. Plankton includes plant organisms (phytoplankton), small animals and developmental stages of the life cycle of marine animals, such as eggs and larvae of fish and benthic organisms (zooplankton), as well as bacteria (bacterioplankton) and fungi (fungi).

2.4.1 Data situation

Only a few monitoring programmes exist for plankton. Previous knowledge on the spatial and temporal variability of phyto- and zooplankton comes from research programmes, a few long-term studies and ecosystem modelling. Remote sensing has also contributed significantly to improving the data situation in recent years. A valuable long-term series has been provided since 1932 by the Continuous Plankton Recorder (CPR) from the area of the Northeast Atlantic and the North Sea (REID et al. 1990, BEAUGRAND et al. 2003). About 450 different phytoplankton and zooplankton taxa have been identified by the CPR recordings; in the North Sea, a total of more than 100 phytoplankton species have been identified (EDWARDS et al. 2005).

The most important data source for the German Bight is the long-term data series Helgoland Reede, which has been continuously collected by the Biological Institute Helgoland (BAH in the AWI Foundation) since 1962 (WILTSHIRE & Manly 2004). At the Helgoland Reede station, investigations of nutrient concentrations with simultaneous recording of temperature, salinity and oxygen are carried out every working day, and since 1967 the phytoplankton biomass has been determined.

Since 1975, the zooplankton of the Helgoland Reede has also been continuously and systematically studied (GREVE et al. 2004).

There is a lack of such long-term series in the German EEZ. Only in the years 2008 to 2011 was the plankton (phyto- and mesozooplankton) studied at 12 selected stations in the German EEZ by the Leibniz Institute for Baltic Sea Research Warnemünde (IOW) on behalf of the BSH as part of the biological monitoring. Sampling took place five times a year in parallel with nutrient sampling (WASMUND et al. 2012). For this reason, the description of the current state will be limited to the investigations at the Helgoland Reede station and to indications from the four-year investigations by the IOW. It should be noted that Helgoland is not representative of the EEZ in terms of hydrography and phytoplankton assemblages. In the period from March 2003 to December 2004, zooplankton samples were also taken and analysed by the research platform FINO1 in the area of the EEZ (OREJAS et al. 2005). The hydrographic conditions in this area of the EEZ vary considerably from those of the Helgoland Reede, especially due to the water depth and the prevailing current. However, a strongly pronounced variability in succession, as found at the Helgoland Reede, was also documented from this area.

2.4.2 Spatial distribution and temporal variability of phytoplankton

Phytoplankton is the lowest living component of marine food chains and comprises small organisms, mostly up to 200 µm in size, which are taxonomically assigned to the realm of plants. They are microalgae that usually consist of a single cell or are able to form chains or colonies from several cells. The organisms of the phytoplankton feed predominantly autotrophically, i.e. through photosynthesis they are able to use the inorganic nutrients dissolved in the water to synthesise organic molecules for growth. Phytoplankton also includes microorganisms that can feed heterotrophically, i.e. from other microorganisms. In addition, there are mixotrophic organisms that can feed auto- or heterotrophically, depending on the situation. Many microalgae, for example, are able to change their type of nutrition in the course of their life cycle. Bacteria and fungi also form separate groups phylogenetically (evolutionary history). When considering phytoplankton, bacteria, fungi and such organisms that are closer to the animal kingdom due to their physiological characteristics are also taken into account. In this report, the term phytoplankton is used in this extended sense.

Important taxonomic groups of the phytoplankton of the southern North Sea and the German Bight are

- Diatoms or diatoms (Bacillariophyta),
- Dinoflagellates or flagellate algae (Dinophyceae) and
- Microalgae or microflagellates of different taxonomic groups.

Phytoplankton serves as a food source for organisms that specialise in filtering the water for food. The most important primary consumers of phytoplankton include zooplanktic organisms such as copepods and water fleas (Cladocera).

Phytoplankton growth in the German Bight shows fixed patterns of occurrence throughout the year. Spatially, the spring growth and thus the algal bloom (mass algal proliferation) only begin in the areas far from the coast, i.e. in the outer area of the German EEZ. From year to year, different diatom species are responsible for the spring algal bloom. *Thalassiosira rotula* forms spring algal blooms particularly frequently (VAN BEUSEKOM et al. 2003).

In summer, the phytoplankton has a low biomass and it is dominated by dinoflagellates and other small flagellates. In autumn, another diatom bloom usually follows (HESSE 1988; REID et al. 1990).

The spatial distribution of phytoplankton depends primarily on the physical processes in the pelagic. Hydrographic conditions, especially temperature, salinity, light, current, wind, turbidity, fronts and tide, influence the occurrence and species diversity of phytoplankton. The North Sea can be roughly divided into two fundamentally different areas for the occurrence of plankton: The area with a year-round mixed water body and the area with strong stratification (vertical stratification) of the water body. As a rule, these also have different nutrient concentrations. The meeting of mixed and stratified water masses is called oceanographic fronts (cf. chapter 2.3.5). These largely determine the occurrence of phytoplankton. Phytoplankton occurs in high abundance in stratified water bodies near the thermocline (layer boundary between superimposed water masses with different temperatures).

In the German Bight, the geographical positions of fronts change depending on the weather situation, the freshwater input from rivers, the tides and wind-induced currents. However, they occur preferentially in the inner areas of the German Bight. In general, nutrient levels in the area of the German coastal sea off the coast of Lower Saxony and in the southern part of the Schleswig-Holstein coast in the area of the Elbe water plume are twice as high as in the northern area of the Schleswig-Holstein coastal sea off Sylt. This is also reflected in the phytoplankton growth and the concentrations of Chlorophylla (VAN BEUSEKOM et al. 2005).

A spatial delimitation of habitat types is therefore only possible to a very limited extent for phytoplankton, unlike e.g. for the benthos. The spatial and temporal distribution of microplankton in the German Bight was specified by HESSE (1988). Large-scale investigations identified three water masses in the German Bight with which the occurrence of phytoplankton is associated. The shift of these main water masses can influence the temporal and spatial development of phytoplankton. In 2010, 144 taxa were identified during biological monitoring, while 140 taxa were identified in 2011 (WASMUND et al. 2011, WASMUND et al. 2012). The majority of the species were diatoms. In the course of the investigations from 2008 to 2011, new species were found every year, while some species from the first years of investigation were no longer found. A total of 193 phytoplankton taxa were found during the four survey years (WASMUND et al. 2012). In 2011, the species *Cyclotella choctawhatcheeana* was probably sighted for the first time, while the otherwise often frequent species *Thalassiosira pacifica, Proboscia indica, Planktolyngbya limnetica, Coscinodiscus granii* and *Prorocentrum minimum* were no longer sighted in 2011 (WASMUND et al. 2012).

2.4.3 Spatial distribution and temporal variability of zooplankton

Zooplankton includes all marine animals floating or migrating in the water column. Zooplankton play a central role in the marine ecosystem, on the one hand as the lowest secondary producer within the marine food chain as a food source for carnivorous zooplankton species, fish, marine mammals and seabirds.

On the other hand, the zooplankton has a special significance as the primary consumer (grazer) of the phytoplankton. Grazing can stop the algal bloom and regulate the degradation processes of the microbial cycle by consuming the cells.

The succession of zooplankton in the German Bight shows distinct seasonal patterns of occurrence. Maximum abundances are generally reached in the summer months. Zooplankton succession is critical for secondary consumers of marine food chains. Predator-prey relationships or trophic relationships between groups or species regulate the balance of the marine ecosystem. Temporally or spatially offset occurrence of succession and abundance of species leads to disruption of food chains. In particular, temporal offset, so-called trophic mismatch, results in food shortages at different developmental stages of organisms with effects on the population level.

Based on the life strategies of the organisms, the zooplankton is subdivided into:

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

The transport and distribution of larvae are of particular importance for the spatial occurrence and population development of nektonic as well as benthic species. Larval dispersal is determined both by the movements of the water masses themselves and by endogenous or species-specific characteristics of the zooplankton. Environmental factors that can influence larval dispersal, metamorphosis and settlement are: Sediment type and structure, meteorological and hydrographical conditions, light, and chemical solutes released into the water by adult individuals of the species.

Characterising habitat types based on the presence of zooplankton is difficult. As already explained for phytoplankton, water masses actually form the habitat of zooplankton. In 2010, a total of 157 zooplankton taxa were identified during the biological monitoring, with Arthropoda being the most abundant group with 80 taxa, followed by Cnidaria with 27 taxa, Polychaeta with 15 and Echinodermata larvae with 9 taxa. The total exceeded that of 2009 by 14 taxa and that of 2008 by 40 taxa. A lower diversity was observed throughout the region off the North Frisian Islands (stations HELGO, AMRU2 and SYLT1, Figure 26). This observation is associated with large-scale water transport off the coast towards Jutland. In 2008, this zone was characterised by an "estuarine plume" with lower salinity and higher chlorophyll values (WASMUND et al., 2009). The spatial distribution of taxa according to the Margalef species richness index shows a typical pattern for estuaries. The values increase with increasing distance from the station at Helgoland, which is closest to the mouth of the Elbe, towards the central North Sea. This experience was already made in the first reporting year, 2008. The result was supported by the changing copepod composition at that time, according to which the proportion of marine genera increased from 20% to over 80% with increasing distance from the coast (WASMUND et al. 2009 and 2011).

In 2011, 139 zooplankton taxa were recorded, with arthropods also being the most common group (WASMUND et al. 2012).

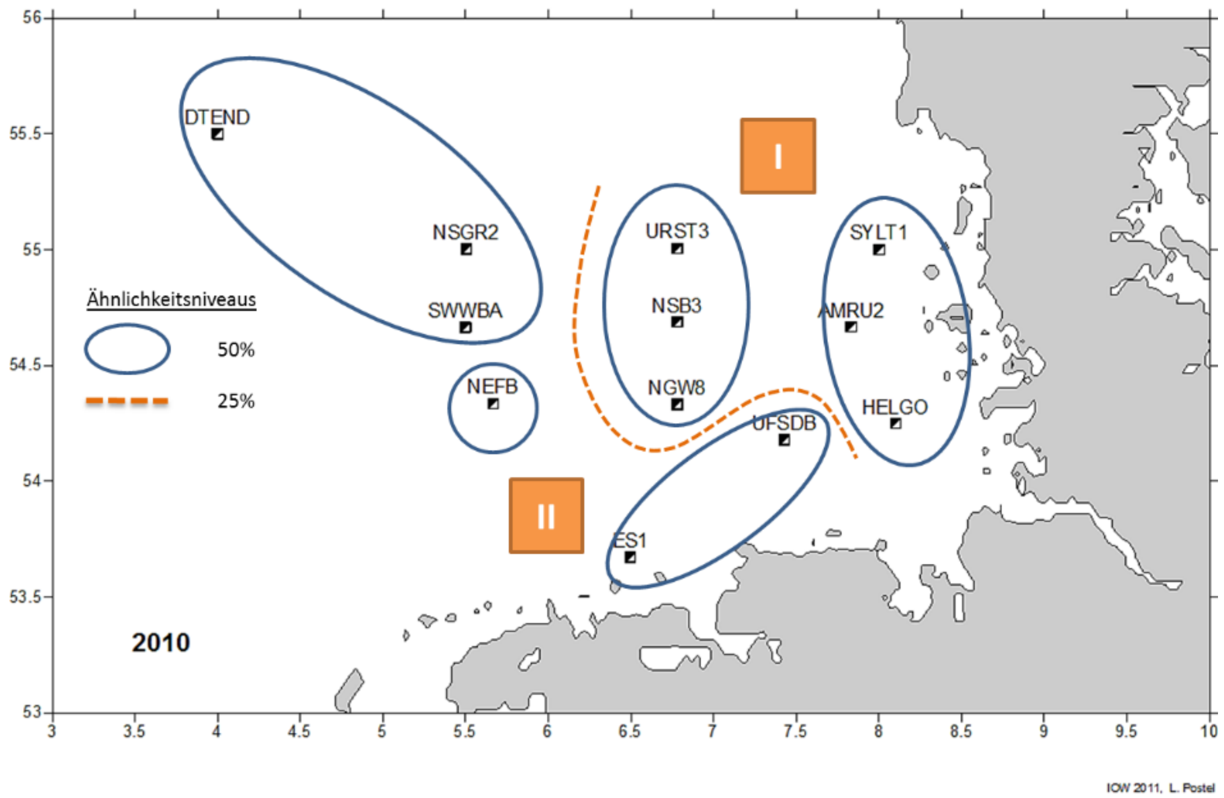


Figure 24: Spatial distribution of mesozooplankton communities according to cluster analysis based on abundances of all taxa and their developmental stages in the German EEZ 2010 (WASMUND et al. 2011).

2.4.4 Condition assessment of the plankton

Overall, taking into account all available long-term data (CPR, Helgoland Reede), changes in both the phyto- and zooplankton of the North Sea can be observed since the end of the 1980s and in the 1990s. The slowly progressing changes concern species range as well as abundance and biomass (ALHEIT et al. 2005, WILTSHIRE & MANLY 2004, BEAUGRAND 2004, REID ET al. 1990).

For example, the evaluation of the **phytoplankton data from** the Helgoland Reede shows a significant increase in biomass since records began. This increasing trend in biomass seems to be related to the development of flagellates. For the German Bight area, a decline of diatoms in favour of small flagellates has been observed since the early 1970s (HAGMEIER & BAUERNFEIND 1990, von WESTERNHAGEN & DETHLEFSEN, 2003). The changes in phytoplankton also concern a weakening of the late summer diatom bloom, a prolongation of the growth phase and the occurrence of algal blooms of non-native species.

Besides natural variability, these changes may be related to anthropogenic influences such as eutrophication and, last but not least, the North Atlantic Oscillation (NAO) and the observed increase in water temperature in the North Sea. However, because plankton is influenced by a wide range of natural and anthropogenic factors, and because very few studies have been carried out in this area, it remains unclear to what extent eutrophication, climate change or simply natural variability contribute to the changes in phytoplankton (EDWARDS & RICHARDSON 2004).

Increasingly, non-native species are also having an impact on succession. The number of alien species spreading anthropogenically in the North Sea has increased significantly in recent years. Alien species are introduced via ship ballast water and mussel aquaculture.

Effects of non-native plankton species on the species composition of native species through displacement, changes in biomass and primary production cannot be excluded. In the entire North Sea, 17 non-indigenous phytoplankton species have been detected in samples (GOLLASCH & TUENTE 2004). Some of the non-indigenous phytoplankton species are now developing pronounced algal blooms in the area of German coastal waters and the EEZ of the North Sea. In the German Bight, for example, the non-native heat-loving diatom species *Coscinodiscus wailesii has* slowly established itself since 1982 and even formed the spring bloom in 2000. A total of 15 non-native species have been found in the zooplankton of the North Sea since 1990 (GOLLASCH 2003).

Based on evaluations of the long-term series from the Helgoland Reede, WILTSHIRE & Manly (2004) have for the first time established a direct link between the increase in water temperature and the shift in phytoplankton abundance in the North Sea. The authors correlated the observed increase in water temperature of 1.13 °C over the period 1962 to 2002 with the mean diatom day (MDD), a calculated parameter of diatom abundance. It was shown that the temperature increase in the above-mentioned period of 40 years has caused a shift in the occurrence of phytoplankton. Thus, following a relatively warm winter quarter, the MDD shifts more towards the end of spring. In such cases, diatoms reach a high abundance.

Based on these results and other studies, the authors point out that although the living conditions of marine organisms have not yet reached limiting ranges, the control mechanisms of seasonal and spatial events have changed significantly (BEAUGRAND et al. 2003). It can be assumed that this also applies to the German EEZ. In addition to the above-mentioned temporal shift or delay in phytoplankton succession (WILTSHIRE & Manly 2004), a possible shift in species could also have consequences for the primary and secondary consumers of the food chains.

Changes in the species composition, abundance and biomass of plankton have consequences both for the primary production of the waters and for the occurrence and populations of fish, marine mammals and seabirds. For example, the reduced abundance of diatoms in favour of small flagellates could have a negative impact on the food chain (VON WESTERNHAGEN & Dethlefsen 2003), as e.g. the introduced C. wailesii*, which is* now highly abundant in the German Bight, is not eaten by primary consumers. Changes in the seasonal course of phytoplankton growth can also lead to trophic mismatch within marine food chains: a delay in diatom growth can affect the growth of primary consumers.

Under certain conditions, phytoplankton can pose hazards to the marine environment. In particular, toxic algal blooms pose a major threat to secondary consumers of the marine ecosystem and to humans. According to REID et al. (1990), a number of phytoplankton taxa are known to be toxic or potentially toxic in the North Sea.

For the **zooplankton,** too, a gradual change since the beginning of the 1990s can be detected. Among other things, the species composition and dominance ratios have changed. While the number of non-native species has increased, many species typical of the area have declined, including those that are part of the ecosystem's natural food resources. In general, the abundance of native cold-water species in the holoplankton has strongly decreased. In contrast, meroplankton has increased (LINDLEY & Batten 2002). The proportion of echinoderm larvae has increased conspicuously. This is mainly associated with the spread of the opportunistic species *Amphiura filiformis (*KRÖNCKE et al. 1998).

The seasonal development or succession of zooplankton in the German Bight correlates predominantly with changes in water temperature. However, the changes in seasonal development differ from species to species.

Overall, in warm years, abundance maxima of various key species occur up to 11 weeks earlier than usual in the long-term trend (GREVE 2001). The growth phase of many species has lengthened overall.

According to HAYS et al. (2005), climate changes have particularly affected distribution limits of species and groups of the North Sea marine ecosystem. Zooplankton associations of warm-water species, for example, have shifted their distribution almost 1,000 km northwards in the Northeast Atlantic. In contrast, the ranges of cold-water associations have shrunk. In addition, climate changes have an impact on the seasonal occurrence of abundance maxima of various groups. The copepod *Calanus finmarchicus, for example,* reaches its abundance maximum 11 days earlier, while its main food, the diatom *Rhizosolenia alata, reaches* its concentration maximum as much as 33 days earlier and the dinoflagellate *Ceratium tripos* 27 days earlier. This staggered population development can have consequences throughout the entire marine food chain. EDWARDS & RICHARDSON (2004) even suggest a particular threat to temperate marine ecosystems due to changes or temporal offsets in the development of different groups.

The threat arises from the direct dependence of the reproductive success of secondary consumers (fish, marine mammals, seabirds) on plankton (food base). Analyses of long-term data for the period 1958 to 2002 for 66 marine taxa have confirmed that marine planktonic associations respond to climate change. However, the responses vary greatly in terms of association or group and seasonality.

2.5 Biotope types

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

The majority of Central European types are also shaped in their concrete expression by the prevailing anthropogenic uses (fishing, raw material extraction, agriculture, traffic, etc.) and impairments (pollutants, eutrophication, recreational use, etc.).

2.5.1 Data situation

The distribution of sandbanks and reefs in the German EEZ of the North Sea is largely known. However, there is currently no spatial mapping of the distribution of biotope types for the North Sea EEZ, so that the occurrence of other marine biotope types can currently only be inadequately represented. Based on information from the BfN database LANIS Habitat Mare, a spatial distribution pattern of higher-level biotope types was created according to FINCK et al. (2017) (Figure 27). On this basis, however, areas of marine biotope types that can be delineated in a sufficiently scientifically robust manner cannot be represented. A detailed and comprehensive mapping of marine biotope types in the EEZ is currently being developed within the framework of ongoing R&D projects of the BfN.

As part of the procedures for the cross-border submarine cable systems COBRAcable and NordLink, detailed surveys of the biotopes located in the vicinity of the planned cable routes were carried out, especially in the area of the Borkum Riffgrund and the Sylt Outer Reef. These findings on the occurrence of protected biotope types are currently being used in ongoing procedures for the most environmentally friendly route planning possible. In addition to information from environmental impact studies, current findings on biotopes from wind farm projects are available for the defined areas (BIOCONSULT 2016b, 2017, 2018; IBL 2016; PGU 2012a, b, 2015; IFAÖ 2015 a, b, 2016).

From a nature conservation perspective, natural biotope complexes ("mosaics") are of particular importance, such as the residual sediment deposits that occur above all in the area of the eastern slope of the Elbe glacial valley (Sylt outer reef) and at the Borkum reef bottom. These biotopes are associated with gravel fields, coarse, medium and fine sand areas, and sometimes even silty sand substrates in small depressions (usually only a thin layer of silt, which is remobilised depending on hydrodynamic conditions). This structural diversity, together with the protection provided by the stones, results in an overall high species diversity.

In the shallower sea areas (about below 30 m), sands found there are regularly shifted in large areas (especially with fine and medium sands) by swells, so that the fauna living there can be very variable (RACHOR & GERLACH 1978). Small rock fields can be so strongly influenced by sand movements (over-sanding, exposure) that long-lived reef communities cannot persist.

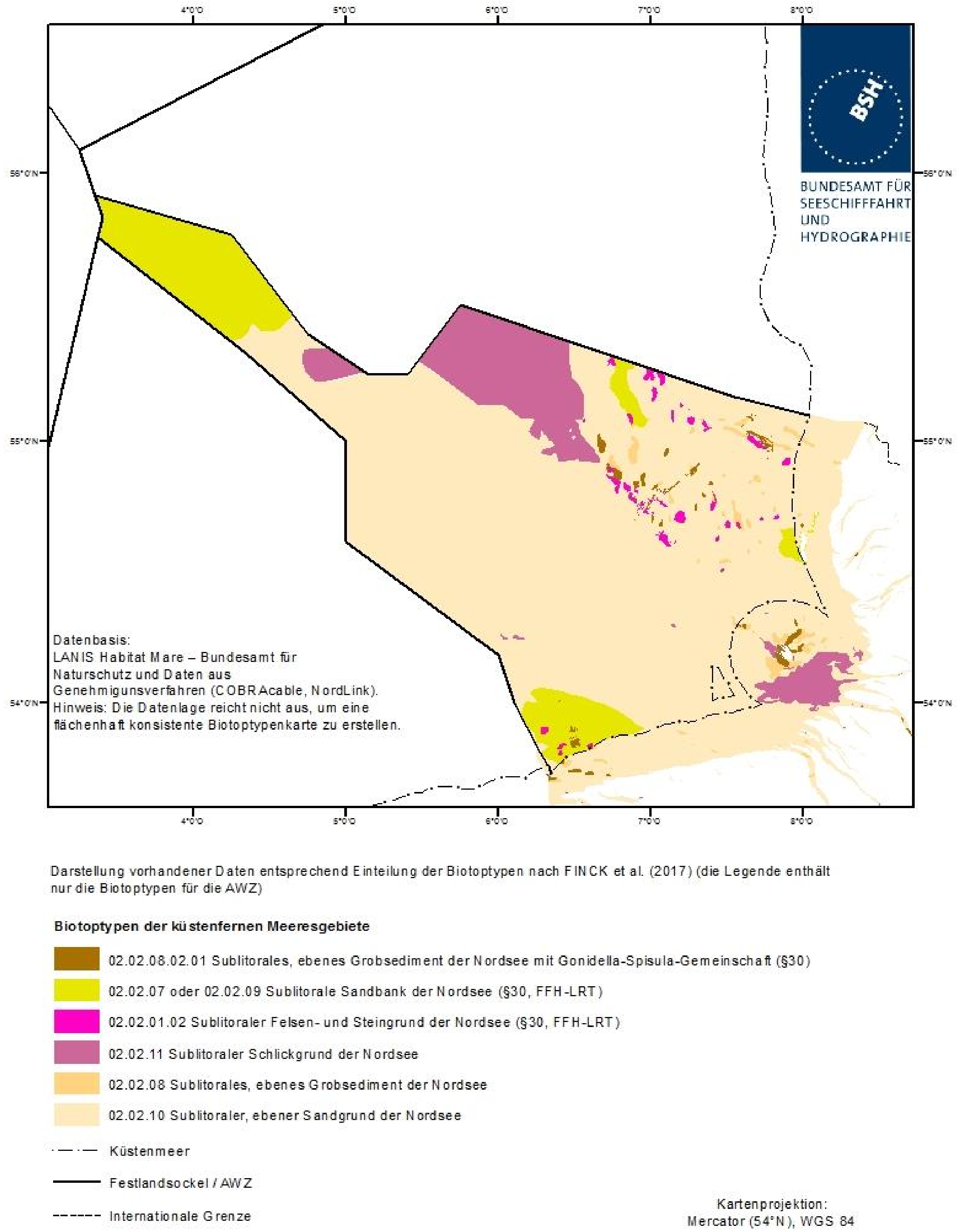


Figure 25: Map of the biotope types of the German North Sea that can be delimited on the basis of existing data.

2.5.2 Legally protected marine biotopes according to sec. 30 BNatSchG and FFH habitat types

In the German EEZ of the North Sea, biotopes of type 1110 "Sandbanks" and 1170 "Reefs", which are to be protected according to EU law (Habitats Directive, Annex I), have been identified so far. Reefs and sandbanks are FFH-LRT and at the same time protected according to sec. 30 BNatSchG.

A number of marine biotopes are subject to direct protection under federal law pursuant to sec. 30 BNatSchG. Sec. 30 para. 2 of the Federal Nature Conservation Act generally prohibits actions that may cause destruction or other significant impairment of the listed biotopes. This does not require the designation of a protected area. This protection was extended to the EEZ with the 2010 amendment to the BNatSchG. In the North Sea EEZ, the following four biotopes of the marine and coastal zone are subject to statutory biotope protection under sec. 30 para. 2 no. 6 BNatSchG: reefs (also FFH-LRT), sublittoral sandbanks (also FFH-LRT), species-rich gravel, coarse sand and shingle beds, and mud beds with drilling megafauna. The biotope type "seagrass meadows and other marine macrophyte stands", which is also protected, does not occur in the North Sea EEZ.

2.5.2.1 Reefs

The LRT 1170 "Reefs" according to the Habitats Directive is defined as follows: "Reefs can be either biogenic intergrowths or geogenic in origin. They are hard substrates on firm and soft substrates rising from the seabed in the sublittoral and littoral zone. Reefs can support the proliferation of benthic algal and animal species communities and intergrowths of coral formations" (DOC.HAB. 06-09/03). The hard substrate includes rocks (including soft rocks such as chalk rocks) and boulders and boulders. Since 09.07.2018, the "BfN Mapping Guidance for "Reefs" in the German Exclusive Economic Zone (EEZ)" (BFN 2018) has been published, which has not yet been applied in the projects.

In the BfN's view, such reefs and reef-like structures are found in some areas in the North Sea EEZ. Areas in the area of the Borkum Reef Ground, in the area of the eastern slope of the Elbe-Urstromtal and the Helgoländer Steingrund should be mentioned in particular. However, there are currently no mapping instructions for the FHH-LRT "Reefs".

For the areas of the Sylt Outer Reef and the Borkum Riffgrund, there are current findings on the occurrence of the LRT "reefs" in the area of the planned COBRAcable cable route. For the survey of the biotope type "reefs" in the German EEZ, the corresponding mapping instructions of the BfN should be consulted (BFN 2018).

2.5.2.2 Sandbanks

LRT 1110, which is protected under the Habitats Directive, denotes "sandbanks with only slight permanent overtopping by seawater" and is defined as follows: "Sandbanks are elevated, elongated, rounded or irregular topographical features that are constantly overtopped by water and surrounded predominantly by deeper water. They are mainly composed of sandy sediments, but may also have coarse rock and stone fragments or smaller grain sizes, including mud. Banks whose sandy sediments occur as a layer over hard substrate are classified as sand banks if the biota living in them depend on sand rather than hard substrate for life." (DOC.HAB. 06-09/03).

In the German EEZ of the North Sea, several sandbanks worthy of protection have been identified from a nature conservation perspective. Large sandbanks are the Dogger Bank and the somewhat smaller Amrum Bank. According to nature conservation experts, the Borkum Reef Ground is an example of a sandbank with stone fields or stony-gravelly areas as reef-like structures. In several BfN study areas, typical sandy bottom communities were found, which develop depending on the sediment type (fine, medium, coarse sand) and the water depth. Areas where different biotic communities occur in alternation are particularly worthy of protection. For these reasons, large areas of the identified sandbanks have been designated by the FFH site notifications "Doggerbank" (DE 1003-301), "Sylt Outer Reef" (DE 1209-301) and "Borkum Reef Ground" (DE 2104-301) and meanwhile also by the legal ordinance of 22.09.2017 establishing the nature reserve "Sylter Außenriff - Östliche Deutsche Bucht", the legal ordinance of 22.09.2017 establishing the nature reserve "Doggerbank" and the legal ordinance of 22.09.2017 establishing the nature reserve "Borkum Riffgrund" in the EEZ of the North Sea. There are currently no mapping instructions for the FFH-LRT "Sandbanks with only slight permanent overtopping by seawater".

2.5.2.3 Species-rich gravel, coarse sand and shingle beds in marine and coastal areas

This biotope includes species-rich sublittoral pure or mixed occurrences of gravel, coarse sand or shingle sediments of the seabed, which are colonised by a specific endofauna (including sand gap fauna) and macrozoobenthos community, regardless of the large-scale location. In the North Sea, these sediments are colonised by a more species-rich macrozoobenthic community than the corresponding medium sand types.

The biotope type may be associated with the occurrence of stones or mixed substrates and the occurrence of mussel beds or occur in spatial proximity to the biotopes "sandbank" and "reef". Reefs and species-rich gravel, coarse sand and shingle beds regularly occur together. In the sublittoral of the North Sea, the biotope type is usually colonised by the *Goniadella spisula community.* This can be identified by the presence of various typical macrozoobenthos species, such as *Spisula elliptica, Branchiostoma lanceolatum, Aonides paucibranchiata.*

The species richness or the high proportion of specialised species in these sediment types results from the occurrence of relatively stable interstitial spaces between the sediment particles with a large proportion of pore water and relatively high oxygen content. RACHOR & NEHMER (2003) have shown that the Goniadella spisula community occurs in two forms in the North Sea EEZ: the more species-rich one on coarse sand and gravel and the less species-rich one on coarse sandy medium sand. If stones are present in the area, a typical epibenthic macrofauna also occurs. In the North Sea, the species-rich habitat usually occurs at depths of more than 20 m, except in the area around Helgoland (ARMONIES 2010). The colonisation of the biotope type is spatially very heterogeneous.

The biotope type "Species-rich gravel, coarse sand and shingle beds in the marine and coastal zone" generally occurs in relatively small areas throughout the North Sea. It is not found in the German North Sea in the area of the Dogger Bank and north of it. The distribution is generally small-scale and patchy (cf. BFN 2011a).

For the areas of the Sylt Outer Reef and the Borkum Riffgrund, there are current findings on the occurrence of species-rich gravel, coarse sand and shingle beds in the area of the COBRAcable cable route.

2.5.2.4 Mudflats with drilling bottom megafauna

The biotope type "Mudflats with burrowing bottom megafauna" is determined by the occurrence of sea pens (Pennatularia), which are particularly sensitive to mechanical disturbance and damage. In addition to sea feathers, the biotope type is characterised by an increased density of burrowing crustacean species (especially *Nephrops norvegicus, Calocaris macandreae, Upogebia deltaura, Upogebia stellata, Callianassa subterranea*). Each burrowing species forms characteristic tunnel systems in the seabed. These create the conditions for oxygen-rich water to penetrate deep into the bottom and thus provide habitats for other species.

"Mudflats with drilling megafauna" occur in the North Sea and the Northeast Atlantic. The potential distribution area results from the distribution of all characterising species. In the German EEZ of the North Sea, it includes in particular the Elbe glacial valley as well as the adjacent areas with fine-substrate sediments at depths of more than 15 m. "Currently, there are no known occurrences of sea feathers in the German North Sea" (BFN 2011b). Without the occurrence of this character species, there is also no evidence for the biotope type "mudflats with drilling megafauna".

As there has been no comprehensive mapping of the above-mentioned biotope types in the German North Sea to date, no specific areas can currently be identified in the North Sea EEZ where the biotopes "Species-rich gravel, coarse sand and mudflats in the coastal and marine area" and "Mudflats with drilling megafauna" occur. In coordination with the BMU, BfN has published a definition and mapping instructions for recording the biotopes species-rich gravel, coarse sand and shingle beds and mud beds with drilling megafauna (BFN 2011a & b).

2.5.3 Condition assessment

The stock assessment of the biotope types occurring in the German marine area is based on the national protection status as well as the endangerment of these biotope types according to the Red List of Endangered Biotope Types of Germany (FINCK et al. 2017). The above-mentioned legally protected biotopes are generally of high importance. In the North Sea, these biotopes are primarily endangered by current or past nutrient and pollutant inputs (including wastewater discharges, oil pollution, dumping, waste and rubble dumping), by fishing activities that come into contact with the ground, and possibly also by the impacts of construction activities. As fishing in contact with the ground is largely excluded within the wind farms, a certain degree of recovery of the biotopes occurring there can be expected in the area of the wind energy zones.

2.5.3.1 Importance of the areas for wind energy for biotope types

Area EN1

The legally protected biotopes "Sublittoral sandbank" and "Species-rich gravel, coarse sand and shingle beds" occur in area N-1. A north-western extension of the 90,000 ha sandbank "Borkum Riffgrund" protrudes into the eastern part of the project area "Borkum Riffgrund West 1" and covers almost 50 % of the project area. The numerous suspected areas of "Species-rich gravel, coarse sand and shingle grounds" in area EN1 are in part large-scale occurrences that occupy larger areas of the project areas "Borkum Riffgrund West 1", "Borkum Riffgrund West 2" and "OWP West" (BIOCONSULT 2016b, 2017). According to the BfN, a larger area in the western part of the project area "Borkum Riffgrund West 2" is a biotope protected under sec. 30 BNatSchG. So far, not all known suspected areas in area EN1 have been investigated according to the BfN mapping instructions (BFN 2011a).

Due to the large-scale occurrence of the biotopes "Sublittoral sandbank" and "Species-rich gravel, coarse sand and shingle beds", area EN1 is considered to be of high overall importance.

Area EN2

A large part of area EN2 is located on the sandbank "Borkum Riffgrund". South to south-west of area EN2 there are occurrences of the legally protected biotopes "Reefs" and "Species-rich gravel, coarse sand and shingle beds, especially in the area of the nature reserve "Borkum Riffgrund". There are no known occurrences of these biotopes within area EN2.

Area EN2 has an overall high biotope importance due to the extensive occurrence of the biotope "Sublittoral Sandbank".

Area EN3

In area EN3, the near-surface sediments consist mainly of a fine- to medium-sand cover layer, the upper decimetres of which are regularly redeposited by hydrodynamic processes of the North Sea. There are no known occurrences of legally protected biotopes for a large part of area EN3. Only a small part of the area extends into the sandbank "Borkum Riffgrund" designated by BfN. According to the BfN's assessment, there are no indications for qualitative-functional special features of the biotope characteristics for this part of the sandbank.

Due to the only slight overlap of area EN3 with the sandbank "Borkum Riffgrund" and the otherwise predominantly homogeneous, fine- to medium-sand sediment conditions, area EN3 is assigned an overall low, and in the southwestern subarea average, significance with regard to the conservation asset biotope types.

Area EN4

So far, there are no indications of the occurrence of legally protected biotopes in area EN4 (IBL 2016). Area EN4 is therefore of low importance with regard to the conservation asset of biotope types.

Area EN5

Due to its location in the area of the Sylt Outer Reef, extensive occurrences of the legally protected biotopes and FFH-LRT "Reefs" and "Sublittoral Sandbanks" are found in part in area EN5. In addition, the legally protected biotope type "Species-rich gravel, coarse sand and shingle beds" occurs in area EN5. The sandbank designated by the BfN in the western part of area EN5 is largely located within the "Sandbank" wind farm.

Due to the partly extensive occurrence of the biotopes "Sublittoral sandbank", "Reefs" and "Species-rich gravel, coarse sand and shingle beds", area EN5 is of high importance in terms of biotopes.

Areas EN6, EN7, EN8, EN9, EN10, EN11, EN12, EN13

The occurrence of legally protected biotopes and FFH-LRTs in the areas EN6 to EN13 can be excluded according to the available knowledge (PGU 2012a, b, PGU 2015, IFAÖ 2015 a,b, IFAÖ 2016, BIOCONSULT 2018). Despite the presence of sediments with partly high silt content and species of burrowing bottom megafauna (Chapter 2.6), the legally protected biotope type "Silt bottoms with burrowing bottom megafauna" can also be excluded due to the absence of sea feathers. Thus, the areas EN6 to EN13 have a low significance for the protected biotope types.

Areas EN14 to EN19

For the areas EN14 to EN18, there are only few findings on biotope occurrences. Site EN19 is located within an occurrence of LRT 1110 "Sandbanks with only slight permanent overtopping by seawater", which is protected under the Habitats Directive (see also Chapter 2.5.2.2).

2.6 Benthos

Benthos is the term used to describe all biological communities at the bottom of water bodies that are bound to substrate surfaces or live in soft substrates. Benthic organisms are an important component 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). According to RACHOR (1990a), the benthos includes microorganisms such as bacteria and fungi, unicellular animals (protozoa) and plants, as well as inconspicuous multicellular organisms and large algae and animals up to bottom-dwelling fish. Zoobenthos are animals that live predominantly in or on the bottom. These organisms largely limit their activities to the vertical boundary area between the free water and the uppermost soil layer, which is usually only a few decimetres.

In the case of the so-called holobenthic species, all life phases take place within this community close to the ground. However, the majority of animals are merobenthic, i.e. only certain phases of their life cycle are bound to this ecosystem (TARDENT 1993). These mostly disperse via planktonic larvae. In older stages, on the other hand, the ability to disperse is lower. Overall, most representatives of the benthos are characterised by a lack of or limited mobility compared to those of the plankton and nekton. Therefore, due to its relative stability, soil fauna can hardly evade natural and anthropogenic changes and pressures and is thus in many cases an indicator of changed environmental conditions (RACHOR 1990a).

The North Sea floor consists largely of sandy or silty sediments, so that animals can also penetrate the bottom. In addition to the epifauna living on the bottom surface, a typical infauna (syn. endofauna) living in the bottom has therefore also developed. Very small animals of less than 1 mm body size (micro- and meiofauna) make up the majority of these soil dwellers. Better known than these tiny animals, however, are the larger animals, the macrofauna, and here especially the more stationary forms such as annelids, mussels and snails, echinoderms and various crustaceans (RACHOR 1990a). Therefore, for practical reasons, the macrozoobenthos (animals > 1 mm) is studied internationally as a representative of the entire zoobenthos (Armonies & ASMUS, 2002). The zoobenthos of the North Sea is composed of a variety of systematic groups and shows a wide range of behaviour. Overall, this fauna is quite well studied and therefore allows comparisons with conditions a few decades ago.

2.6.1 Data situation

The basis for the description and assessment of the status of the macrozoobenthos in the North Sea is, in addition to the existing literature, in particular data collected in the context of various environmental impact assessments of offshore wind farm projects and the accompanying ecological research. Evaluations of the R&D project "Assessment approaches for spatial planning and approval procedures with regard to the benthic system and habitat structures" form an essential basis (Dannheim ET al. 2014a). As part of the project, a comprehensive database on benthic invertebrates and demersal fish was built up, which enables both temporal and spatial large-scale analyses on the occurrence of animals in the German EEZ of the North Sea. For this purpose, benthic data from environmental impact studies from approval procedures for offshore wind farms and submarine cables as well as from research projects were subjected to harmonisation and quality control and integrated into a database. In addition, from 2008 to 2011, the benthos at 12 selected stations in the German EEZ was investigated by the IOW on behalf of the BSH and as part of the biological monitoring. Sampling took place twice a year (WASMUND et al. 2011).

A data set for the entire North Sea was produced as part of the North Sea benthic surveys in April 1986. These surveys were initiated by the ICES Benthos Ecology Working Group (DUINEVELD et al. 1991). For the German North Sea, various data sets are available for periods ranging from several years to two to three decades. The first benthic surveys in the German Bight were carried out by HAGMEIER (1925) in the 1920s. These investigations provide basic information on the structure of the macrozoobenthic communities. These investigations were continued between 1949 and 1974 by ZIEGELMEIER (1963, 1978). RACHOR (1977, 1980) studied the macrofauna communities of the inner German Bight from 1969 onwards and found a decrease in species numbers. RACHOR & GERLACH (1978) analysed sandy areas of the German Bight with regard to the effects of strong storms on the benthic communities.

KRÖNCKE (1985) and WESTERNHAGEN et al. (1986) studied the influence of extremely low oxygen concentrations on the macrozoobenthos in the German Bight and in Danish waters during the summers of 1981 to 1983. The studies showed a decrease in species numbers and biomass as well as an increase in opportunistic species.

In the subsequent years 1984 to 1989 without oxygen deficiency situations, a rapid regeneration of these macrozoobenthos communities was determined (NIERMANN 1990 and NIERMANN et al. 1990).

The analysis of long-term data sets showed changes in the composition of the macrobenthos. In STRIPP's (1969 a/ b) comparison of data sets from the German Bight between 1923 and 1965 - 1966, no significant change in the benthic communities could yet be detected compared to Hagmeier's investigations. NIERMANN (1990) compares Hagmeier's and Stripp's data with his investigations from 1984 to 1989 and describes a doubling of biomass caused, among other things, by the increase in *Echinocardium cordatum* and opportunistic species such as *Phoronida.* SALZWEDEL et al. (1985), in turn, studied the entire German Bight and found an increase in biomass compared to earlier studies. They cite nutrient abundance as a possible reason.

RACHOR (1990b) describes changes in macrozoobenthic communities on different sediment types as a result of eutrophication. According to these studies, sandy sediments are more strongly influenced by the input of organic material than silt. During investigations of the epibenthos of the German Bight, REISE & BARTSCH (1990) discovered that the fauna was more diverse in the past than during their surveys. Further studies show that fishing with heavy bottom gear leads to changes in the benthic communities, with a decline of long-lived and fragile species within the studied communities (FRID et al. 1999; LINDEBOOM & DE GROOT 1998).

Analyses by KRÖNCKE et al. (2011) of the entire North Sea for the period 1986 to 2000 show little change in the large-scale distribution of macrofauna. Changes in abundance and regional distribution of individual species were largely associated with temperature changes.

Results from DANNHEIM et al. (2014a) were used to describe the biotic communities in the defined areas. Based on data from 41 wind farm projects and 15 AWI projects in the period 1997-2014, analyses of the benthic communities were carried out in this study, firstly on a large scale for the entire EEZ and secondly regionally at the scale of the areas. addition, further current findings from the literature are included in the following chapters.

2.6.2 Spatial distribution and temporal variability

The spatial and temporal variability of zoobenthos is largely controlled by climatic factors and by anthropogenic influences. Important climatic factors are winter temperatures, which cause high mortality of some species (BEUKEMA 1992, ARMONIES et al. 2001). The analysis of a long-term data set from 1981-2011 by GHODRATI SHOJAEI et al. (2016) was able to confirm that winter temperatures and the North Atlantic Oscillation (NAO) are the predominant environmental factors determining the temporal variability of the macrozoobenthos in the German Bight. Regional oscillations of temperature, salinity and near-surface currents caused by the NAO have a strong structuring character on benthic communities, especially seasonally but also in the medium term (KRÖNCKE et al. 1998, TUNBERG & NELSON 1998). A spatial distribution of benthic organisms projected to the year 2099 due to expected climate changes suggests a northward shift and a high degree of habitat loss for a number of key species, especially for the southern North Sea, with possible impacts on ecosystem function (WEINERT et al. 2016).

Wind-induced currents are responsible for the dispersal of planktonic larvae as well as for a redistribution of bottom-dwelling stages through current-induced sediment rearrangements (ARMONIES 1999, 2000a, 2000b). Among anthropogenic impacts, besides nutrient and pollutant discharges, disturbance of the bottom surface by fishing is of particular importance (RACHOR et al., 1995). Bottom trawling can affect the structure and trophic function of benthic communities (DANNHEIM et al. 2014b), even in areas that have already been heavily damaged (REISS et al. 2009).

The natural classification of the German EEZ of the North Sea according to benthological criteria presented below differs from the natural classification according to sedimentological criteria. Although the macrozoobenthos is strongly linked to the sediment structure (KNUST et al. 2003), water temperature and the hydrodynamic system (currents, wind, water depth) are among the main structuring natural factors in the German Bight that are responsible for the composition of the macrozoobenthos. RACHOR & NEHMER (2003) therefore subdivide the area into seven natural units (abbreviations A - G), which are listed in Table 8and shown graphically in Figure 29

Central guiding structures in the German EEZ of the North Sea are the Elbe glacial valley and - in the outer area - the Dogger Bank. These are important e.g. for habitat connectivity, as stepping stones and as refuges. The Dogger Bank is also a biogeographical divide between the northern and southern North Sea.

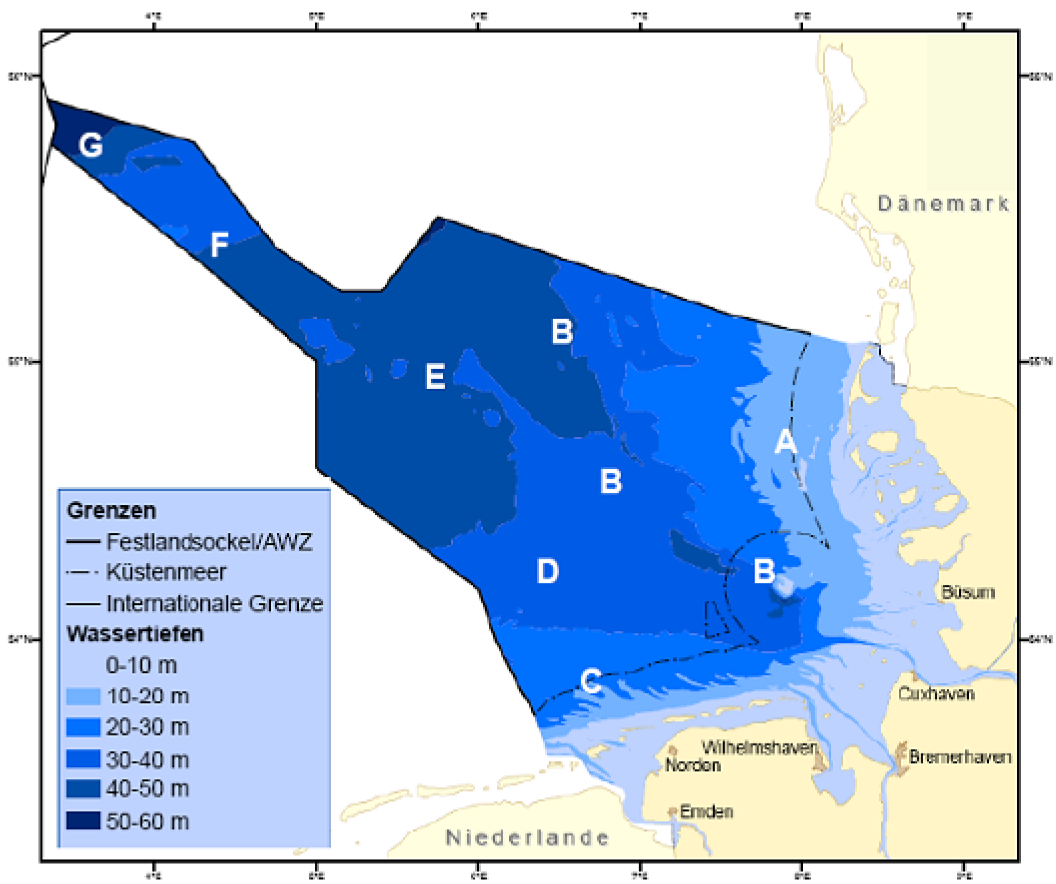


Figure 26: Natural classification of the German North Sea EEZ according to RACHOR & NEHMER (2003), final report for BfN.

Table 8: Natural units of the German EEZ of the North Sea (after RACHOR & NEHMER 2003).

KÜRZEL cf Figure 29	DESCRIPTION	HYDROGRAPHY	TOPO GRAPHY	SEDIMENT*	BENTHOS
A	Eastern German Bight (North Frisian EEZ) with Sylt Outer Reef	Changing salinity with frontal systems between North Sea water and freshwater input from the major rivers; high nutrient concentration, higher pollutant concentration than in the rest of the EEZ; northward flow of residual current (CCC).	from -10 to-43 m	Heterogeneous sediment distribution of fine to coarse sands, isolated gravel and stone surfaces	Predominantly **Tellina-fabula community** (dominant species: ribbed flat clam and spionid annelids), adaptable; shoreward the sublittoral variant of the Macoma-balthica community; **Gonia-della-Spisula community** high species diversity in biotope mosaics with often lower colonisation densities.
B	Elbe-Urstromtal	Water bodies seasonally stratified at times, regionally with oxygen depletion; lower salinity coastal water may overlie higher salinity water	Elongated hollow form, steeper on the eastern slope up to -50 m	Fine sands with silt content that increases with water depth	**Amphiura filiformis community** (dominant species: brittle star); drilling megafauna possible in parts; Nucula nitidosa community in the mud and silt sand areas closer to the coast.
C	Southwest German Bight (coastal East Frisian EEZ with Borkum reef bottom)	Inflow of Atlantic water from the Channel and the western North Sea; easterly flow	from -20 to-36 m	Heterogeneous sediment distribution of fine to coarse sands, sporadic gravel and individual stone occurrences	Predominantly **Tellina-fabula community** (dominant species: ribbed flat mussel and spionids), adaptable; as well as **Goniadella-Spisula community** high species diversity in biotope mosaics with often lower colonisation densities.
D	Northwest German Bight (offshore East Frisian EEZ)	under North Sea water influence; slight easterly flow	from -30 to-40 m	Silty fine sand	**Amphiura filiformis community** (dominant species: brittle star); boring megafauna possible in some areas
E	Transition area between German Bight and Dogger Bank	low tidal dynamics with low amplitude; stratified water body in summer; high salinity with low variability; oxygen deficiency possible	Depths from -38 (shallow ground White Bank) to - 50 m	Silty fine sand	**Amphiura filiformis community** (dominant species: brittle star); boring megafauna possible in some areas
F	Dogger Bank	On the slopes, eddies and fronts form; strong vertical mixing on the bank, water bodies rarely stratified	Depths from-29 to -40m, shallowing to W	Fine to medium sand	Coastal fine sand community **Bathyporeia-Tellina community**

KÜRZEL cfFigure 29	DESCRIPTION	HYDROGRAPHY	TOPO GRAPHY	SEDIMENT*	BENTHOS
G	Central North Sea north of the Dogger Bank	Water regularly stratified during the summer months	Depths over - 40 m	Fine sands, in places boulder clay or clover.	Benthic community of the central North Sea, Myriochele

*modified BSH

2.6.2.1 Current species range of the North Sea EEZ

Currently, a total of about 1,500 marine macrozoobenthos species are known in the North Sea. Of these, an estimated 800 are found in the German North Sea area, and probably 700 in the sublittoral of the open south-eastern North Sea (RACHOR et al. 1995). Studies on the benthos of the EEZ were carried out as part of the investigations of the R&D project "Recording and Evaluation of Ecologically Valuable Habitats in the North Sea" (Rachor & NEHMER 2003) IN May/June 2000 using van Veen grab samples at 181 stations and with additional 79 beam trawl hauls. A total of 483 taxa (of which 361 were identified to species) of the endo- and epifauna including demersal fish were identified. The groups of Polychaeta (polychaetes) with 129 species, Crustacea (crustaceans) with 101 species and Mollusca (molluscs) with 66 species accounted for the largest share. A total of 336 invertebrate macrozoobenthos species were detected.

The species spectrum recorded by RACHOR & NEHMER (2003) can be supplemented by the studies carried out in the context of various offshore wind farm and submarine cable projects as well as additional research projects of the AWI. Based on a taxonomic harmonisation of this extensive benthic database, 573 species were recorded between 1997 and 2014 for the benthic infauna alone in the area of the German EEZ (DANNHEIM et al. 2016). This results in a total number of invertebrate macrozoan species in the German EEZ of about 750 species. In the ranking of species diversity of individual large groups, the group of Polychaeta is the most species-rich, followed by Crustacea and Mollusca.

Within the framework of the biological monitoring of the IOW, a total number of species (spring and autumn sampling of all stations combined) of 286 was recorded in 2010. Along the stations, the species diversity ranged from 37 in the area of the North Frisian Islands to 121 in the Duck's Bill. Looking at the spring and autumn sampling separately, the species numbers in spring varied between 16 in the North Frisian Islands area and 90 in the Duck's Bill. In autumn, the species diversity was always higher (WASMUND et al. 2011).

2.6.2.2 Red List species

In May 2014, the current Red List of bottom-dwelling marine invertebrates by RACHOR et al. (2013) was published by the BfN. By including additional animal groups compared to the 1998 Red List, the current Red List includes assessments for a total of 1,244 macrozoobenthos taxa. According to this, 11.7% of all assessed taxa are endangered, and a further 16.5% are potentially endangered as species that are probably stable on a large scale, but extremely rare. If the 3.9% of lost species (48 of the total of 49 lost species were only found in the Helgoland area) are added, a total of 32.2% of all assessed species are assigned to a Red List category.

In a recent study by DANNHEIM et al. (2016), a total of 98 species of benthic invertebrates listed as endangered or extremely rare according to

RACHOR et al. (2013) were recorded in the area of the German EEZ between 1997 and 2014.

Two of the species found are considered extinct (*Modiolula phaseolina* and *Ascidia virginea*). The detection of the sea squirt *Ascidia virginea is* considered a misidentification according to the latest findings. According to post-determination, this is most likely the extremely rare (Red List Cat. R) species *Ascidiella scabra* (J. DANNHEIM pers. commun., species list currently under revision).

The two species *Nucula nucleus* and *Spatangus purpureus* are classified as threatened with extinction (Red List Cat. 1). A further seven species (*Buccinum undatum, Echiurus echiurus, Ensis enis, Modiolus modiolus, Sabellaria spinulosa, Spisula elliptica, Upogebia stellata*) are critically endangered (Red List Cat. 2). Nine further species are classified as endangered (Red List Cat. 3). For a total of 33 species, an endangerment of unknown extent (Red List Cat. G) is to be assumed, 45 species occur extremely rarely (Red List Cat. R). In addition to these 98 Red List species, a further 17 species are on the Forewarned List. The major taxonomic groups with the highest number of Red List species are molluscs (Bivalvia, 30 species), polychaetes (Polychaeta, 26 species) and amphipods (Amphipoda, 20 species).

According to a recent study by DANNHEIM et al. (2016), the benthic Red List species are not homogeneously distributed in the German EEZ. Overall, more Red List species occur with increasing distance from the coast, with up to 15 Red List species per station in the Dogger Bank area. Local hotspots in terms of species numbers and abundance of Red List species are mainly found in the area of the Dogger Bank, the Sylt Outer Reef and northwest of the Sylt Outer Reef (Figure 30). According to DANNHEIM et al. (2016), the distribution of Red List species in the German EEZ is largely determined by water depth, temperature and sediment properties, in addition to distance from the coast, and thus does not differ significantly from the distribution patterns of the rest of the benthic fauna.

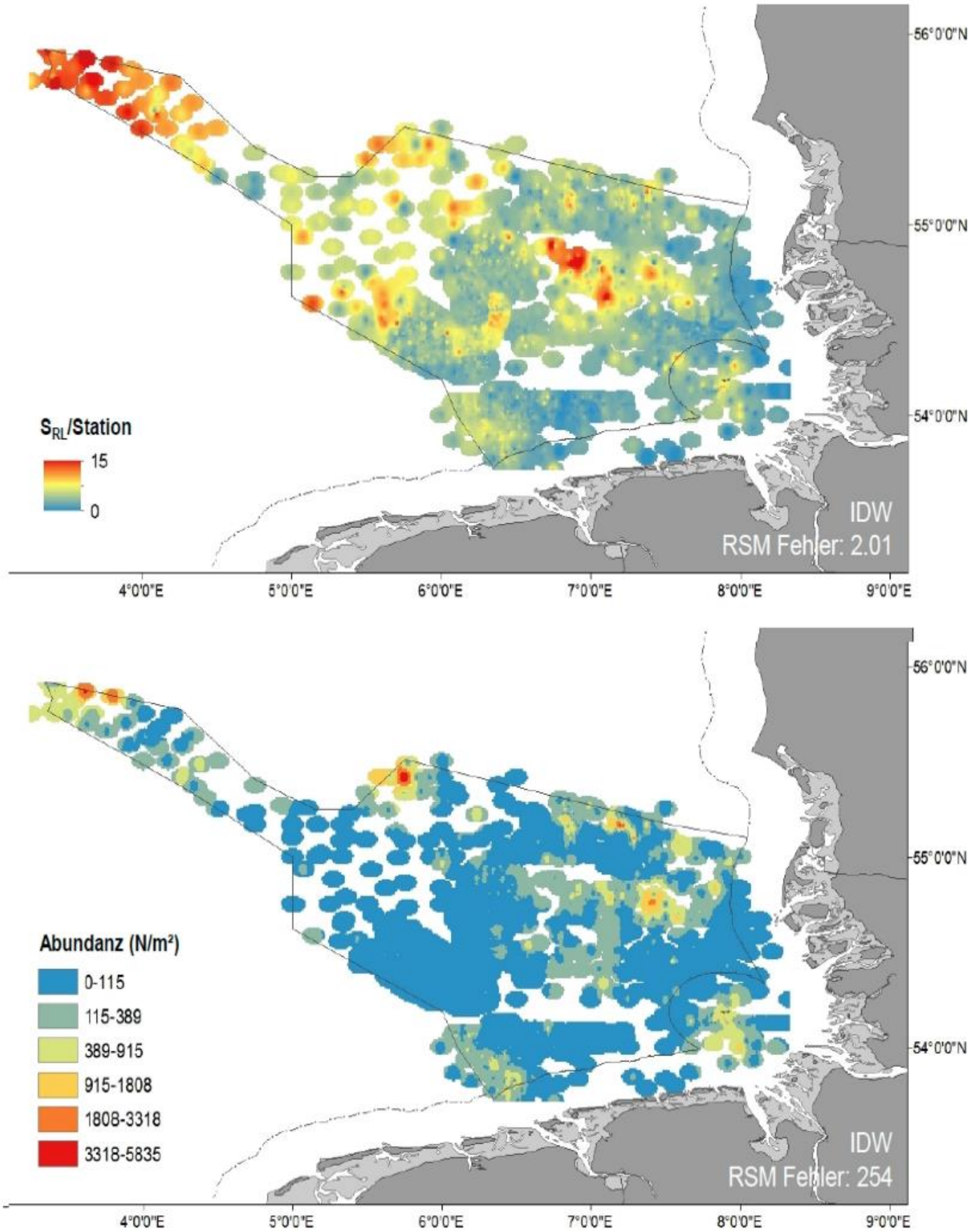


Figure 27: Number of species (top) and abundance (bottom) of Red List benthic species in the German EEZ area (from DANNHEIM et al. 2016).

2.6.2.3 Living communities

In general, the infauna is distributed in correlation to water depth and sediment. The distribution pattern of bottom fauna communities described by SALZWEDEL et al. (1985) and in principle already by HAGMEIER (1925) has been confirmed again and again, although there are study- or time-dependent differences in dominance ratios and in the occurrence of individual species as well as in small-scale details. The overall distribution of benthic endofauna communities in the North Sea based on a mapping exercise coordinated by the Benthos Ecology Working Group of ICES and carried out in 1986 is described in KÜNITZER et al. (1992). A clear south-north zonation was found (HEIP et al. 1992), which is mainly due to the water depths and the associated temperature and stratification conditions. Within this large-scale zonation, the distribution of the communities is predominantly determined by the sediments.

The settlement areas of the macrozoobenthos recorded with bottom grabs in the southeastern North Sea in 2000 (RACHOR & NEHMER 2003) are shown in simplified form in Figure 32largest areas in the EEZ are occupied by the *Amphiura filiformis*, *Tellina fabula* and *Nucula nitidosa communities*; on the Dogger Bank, the *Bathyporeia tellina community is most* abundant.

These communities show changes mainly due to fishing with heavy bottom gear; some formerly common species such as *Arctica islandica* are hardly present here anymore.

The variants of the *Goniadella spisula community,* often associated with stone reefs and stone fields, occur in the area of the Borkum reef bottom and especially east of the Elbe glacial valley. In the case of larger stone accumulations, there is some protection from bottom fishing; however, these biotope mosaics are now threatened by gravel and sand extraction.

The *Myriochele community* found in the transition area to the central North Sea north of the Dogger Bank is widespread there outside the German EEZ. For German waters, however, this community is unique. This is another reason why this area is home to a particularly large number of species on the RACHOR et al. (2013) Red List for the German marine area (cf. Table 8).

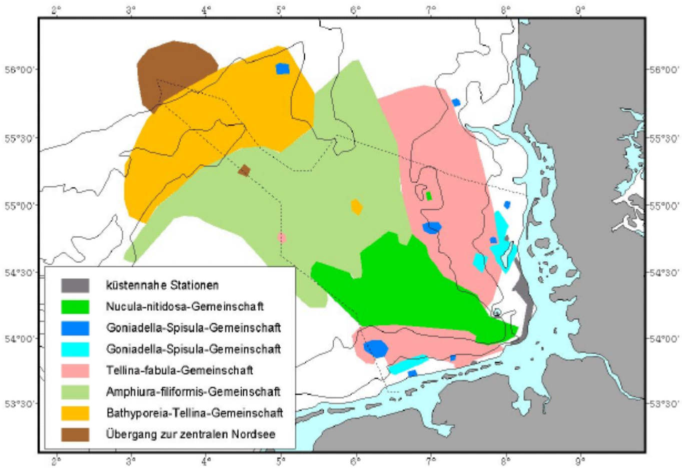


Figure 28: Settlement areas of the most important bottom-dwelling animal communities (macrozoobenthos, according to bottom grab samples) in the German EEZ of the North Sea and adjacent areas (from RACHOR & NEHMER 2003, final report for BfN); in the area of the territorial sea the representation is incomplete.

Based on data from 41 wind farm projects and 15 AWI projects in the period 1997-2014, DANNHEIM et al. (2014a) conducted analyses of benthic communities, firstly on a large scale for the entire EEZ and secondly regionally at site scale.

For the benthic **epifauna**, six significantly different communities were identified on a large-scale and regional scale (Figure 34. However, the identified associations are not spatially clearly delimitable units, but reflect gradual changes in abundance ratios between the nearshore and offshore stations in an essentially constant structural species composition. Dominant and regularly occurring character species in the entire EEZ are *Asterias rubens* (common starfish), *Astropecten irregularis* (northern comb starfish), *Crangon* spp. (North Sea crab), *Liocarcinus holsatus (*common swimming crab), *Ophiura ophiura (*large brittle starfish), *Ophiura albida (*small brittle starfish) and *Pagurus bernhardus* (hermit crab). In particular, the nearshore communities are dominated by some dominant species (e.g. *Crangon* spp. and *Ophiura albida*), while the dominance ratios in the offshore regions are more balanced. The more productive nearshore regions also have higher abundance and biomass values than the offshore regions.

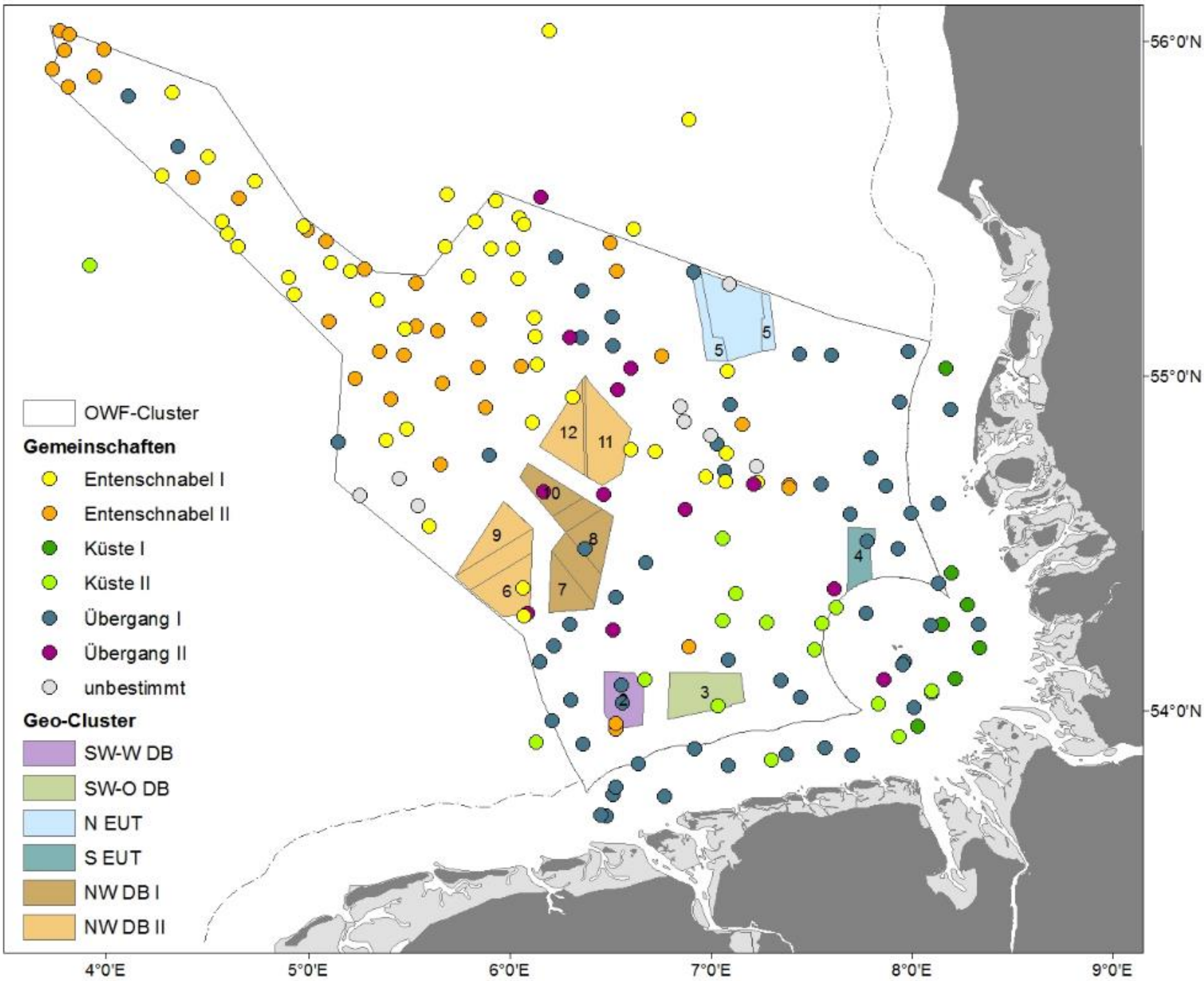


Figure 29: Identified large-scale communities and regional geo-clusters based on abundances of epifauna in the German North Sea EEZ (after DANNHEIM et al. 2014a). SW-W DB = western Southwest German Bight, SW-O DB = eastern Southwest German Bight, N EUT = northern Elbeurstrom Valley, S EUT = southern Elbeurstrom Valley, NW DB I = northwest German Bight I, NW DB II = northwest German Bight II.

For the benthic **infauna,** the communities of the German EEZ described by SALZWEDEL et al. (1985) and RACHOR & NEHMER (2003) with the associated character species could be confirmed (Figure 36addition to the established communities, seven further communities were identified, which essentially represent gradual transitional communities between the established associations. In contrast to the epifauna, no clear gradients depending on the distance from the coast are discernible for the infauna. Rather, according to DANNHEIM et al. (2014a), sediment properties have the greatest influence on the composition of the infauna. This in turn implies a relatively high degree of small-scale variability in the faunal structure of the infauna, especially in sedimentologically heterogeneous areas, such as the Amrum Bank and the Sylt Outer Reef.

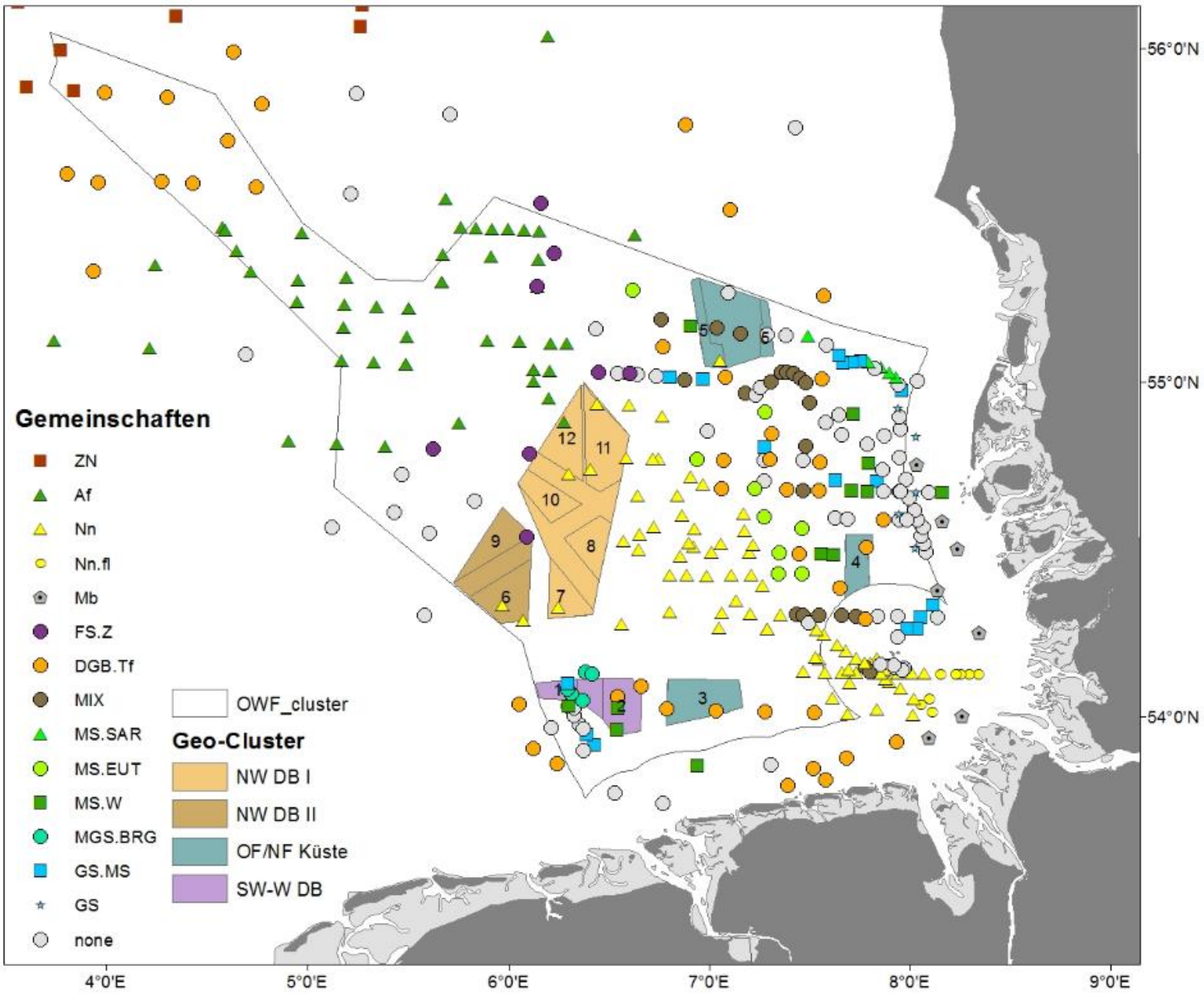


Figure 30: Identified large-scale communities and regional geo-clusters based on abundances of infauna in the German North Sea EEZ (after DANNHEIM et al. 2014a). Cluster: ZN = Central North Sea, Af = Amphiura filiformis community, Nn = Nucula nitidosa community, Nn.fl = shallow Nucula nitidosa community, Mb = Macoma balthica community, FS.Z = fine sand central, DBG.Tf = Doggerbank/Tellina fabula community, MIX = heterogeneous sands, MS.SAR = medium sand Sylt outer reef, MS.EUT = medium sand Elbe Urstromtal, MS.W = medium sand west, MGS.BRG = medium coarse sand Borkum Riffgrund, GS.MS = coarse sand medium sand, GS = Goniadella/Spisula medium coarse sand, none = not defined. Geo-Cluster: SW-W DB = Western Southwest German Bight, OF/NF Coast = East Frisian/North Frisian Coast, NW DB I, II = Northwest German Bight I, II.

2.6.3 Status assessment of the benthos as a protected resource

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

Criterion: Rarity and endangerment

The number of rare or endangered species is taken into account here. The rarity/endangerment of the population can be assessed on the basis of the Red List species detected.

According to the currently available studies, the macrozoobenthos of the North Sea EEZ is considered average based on the number of Red List species detected. This assessment is supported by the fact that in the Red List of RACHOR et al. (2013) a total of 400 species out of 1,244 assessed species are assigned to a Red List category. The 400 species represent over 30% of the total population.

In the recent surveys by DANNHEIM et al. (2016), 98 endangered or extremely rare Red List species were identified in the North Sea EEZ from 1997-2014, representing approximately 13.1% of the total number of species recorded (750).

Two species considered extinct (Red List Cat. 0) and two species threatened with extinction (Red List Cat. 1) were detected. The detection of one species considered extinct has since been proven to be a misidentification (J. DANNHEIM pers. comm.). In contrast, RACHOR et al. (2013) list 49 species of Red List Cat. 0 and eight of Red List Cat. 1. The individual consideration of the natural units defined by RACHOR & NEHMER (2003) does not lead to any deviating assessment of the status of the macrozoobenthos.

Criterion: Diversity and distinctiveness

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

The species inventory of the North Sea EEZ can be regarded as average, with currently about 750 recorded macrozoobenthos species (excluding fish), because currently a total of about 1,500 marine macrozoobenthos species are known in the North Sea and, according to RACHOR et al. (1995), an estimated 800 of these are found in the German North Sea area. The benthic communities do not show any special features either, because the main structuring natural factors for the composition of the macrozoobenthos in the German Bight are the water temperature, the hydrodynamic system (currents, wind, water depth) and the resulting sediment composition (KNUST et al. 2003).

According to the predominant sediments, the largest spaces are occupied by the *Amphiura filiformis*, *Tellina fabula* and *Nucula nitidosa communities. In* coarse sandy areas, the *Goniadella-spisula community* predominates. However, their occurrence extends beyond the German EEZ. The *Myriochele community* joins north of the Dogger Bank and is widespread outside the German EEZ (RACHOR et al. 1998). Overall, none of the benthic communities found in the area is of outstanding importance. According to KRÖNCKE (2004), the six benthic communities found in the North Sea are characterised by frequently represented leading forms. However, this does not mean that their respective species inventory is limited to individual communities. Only the frequencies are characteristic, but the individual species are also present in the other communities. Therefore, these biotic communities could not be differentiated in terms of their value; rather, all biotic communities had the same value.

Criterion: Preload

For this criterion, the intensity of fishing exploitation, which is the most effective direct disturbance variable (e.g. HIDDINK et al. 2019, EIGAARD ET AL. 2016, BUHL-MORTENSEN et al. 2015 and literature cited therein), is used as an assessment criterion. Furthermore, benthic communities can be affected by eutrophication. For other disturbance variables, such as shipping traffic, pollutants, etc., suitable measurement and detection methods are currently still lacking in order to be able to include them in the assessment.

With regard to the criterion pre-stress, it can be stated that the benthos deviates from its original state due to pre-stress (fishing, eutrophication and pollutant inputs). Particularly noteworthy here is the direct disturbance of the bottom surface by intensive fishing activity, which causes a shift from long-lived species (mussels) to short-lived, rapidly reproducing species. Therefore, neither the species composition nor the biomass of the zoobenthos today corresponds to the state that would be expected without human uses (ARMONIES & ASMUS 2002).

In summary, it can be stated that the EEZ of the North Sea is not of outstanding importance with regard to the species inventory of benthic organisms. The benthos of the North Sea EEZ is typical for the German North Sea and reflects in particular the sediment and depth conditions and the preloading by anthropogenic influences.

2.6.3.1 Importance of the areas for benthic communities

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

Priority areas for wind energy EN1 and EN2

The regional geo-cluster SW-W DB (western Southwest German Bight) identified by DANNHEIM et al. (2014a) based on a comprehensive analysis of data from wind farm and AWI projects comprises areas EN1 and EN2 (Figure 36). In a comparison of the two areas, area EN1 has a greater overall structural heterogeneity of benthic communities and the second highest heterogeneity of all areas. The predominant character species in areas EN1 and EN2 were the polychaetes *Magelona* spp., *Spiophanes bombyx, Nephtys cirrosa and amphipods of the genus Bathyporeia spp.* In terms of species numbers and abundance of Red List species, areas EN1 and EN2 show local hotspots (Figure 30). The variants of the *Goniadella spisula community occurring in* these areas have a high significance in terms of rarity and endangerment due to the relatively high number of Red List species. In its species-poorer form, this community has medium importance in terms of diversity and distinctiveness. However, it is of high importance in this respect in areas that are classified as "species-rich gravel, coarse sand and shingle beds" according to sec. 30 BNatSchG. The preloading of the *Goniadella spisula community* is low to medium due to an overall relatively low fishing intensity (<1 event per year) in the Borkum Riffgrund area. Overall, the *Goniadella spisula communities* occurring in areas EN1 and EN2 are assessed as medium in their species-poor variant, but as high in the species-rich expression.

Areas wind energy EN3, EN4 and EN5

The nearshore geo-cluster "OF/NF Coast" (East Frisian/North Frisian Coast) in areas EN3, EN4 and EN5, delineated on the basis of the analysis by DANNHEIM et al. (2014a), is similar in species composition to the community in areas EN1 and EN2. Here too, the polychaetes *Magelona* spp. and *Spiophanes bombyx* were the predominant character species, along with Nemertea and Phoronida. The community detected in these areas had the highest abundances overall. The highest structural heterogeneity of the benthic communities compared to all areas was found in area EN5, mainly due to the high variability in the wind farms "Dan Tysk" and "Sandbank".

The community found in area EN3 is predominantly the *Tellina-fabula association*. In the northern part of area EN3 there is a transitional area to the *Nucula nitidosa community*. The high presence of the polychaetes *Magelona johnstoni* and *Spiophanes bombyx* in this area confirms the geo-cluster "OF/NF Coast" described in DANNHEIM et al. (2014a).

The benthic communities found in the area of site EN3 are neither rare nor endangered in the North Sea EEZ. Overall, the benthic communities can be assigned a low to medium importance due to an average species diversity and number of Red List species as well as the preloading by fishing.

Priority areas for wind energy EN6 and EN9

In the area of areas EN6 and EN9, the geo-cluster NW DB II (Northwest German Bight II) was identified by DANNHEIM et al. (2014a). The community occurring in these areas essentially corresponds to the *Amphiura filiformis association* with elements of the *Nucula nitidosa association* added mainly in area EN6. The predominant character species in areas EN6 and EN9 were the mole crab *Callianassa subterranea*, the polychaet *Nephtys hombergii*, the brittle star *Amphiura filiformis* and the Phoronida. Overall, these areas had the lowest mean abundance and number of species compared to the other geo-clusters.

The number of Red List infauna species according to RACHOR et al. (2013) varied between 15 and 21 species in the area of site EN6. The mussel *Spisula elliptica,* which is considered critically endangered (Red List category 2), as well as the mussels *Arctica islandica* and *Goodallia triangularis,* which are classified as endangered, and the scale worm *Sigalion mathildae* were each detected with only a few individuals. In addition, two species of burrowing soil megafauna were detected. The endangered species *Callianassa subterranea* was found relatively frequently, while the endangered species *Upogebia deltaura* was found only in small numbers.

Despite the average species diversity and number or abundance of Red List species, the benthic community in the area of site EN6 is considered to be of average to above-average importance due to the occurrence and ecological importance of burrowing bottom megafauna.

Based on data collected in 2008-2009, the benthic community in area EN9 can be assigned to the *Amphiura filiformis association.* Between 128 and 130 macrozoobenthos taxa were detected within site EN9 (PGU 2012a, b; PGU 2015). Despite a relatively large temporal variability in species composition, the same species dominated the benthic community as in area EN6, namely *Nucula nitidosa, Corbula gibba, Nephtys hombergii* and *Amphiura filiformis. In* addition, the horseshoe worm *Phoronis* spp., the mole crab *Callianassa subterranea* and polychaetes of the genus Nephtys were added as dominant species. In terms of biomass, the heart sea urchin *Echinocardum cordatum* and the turret snail *Turitella communis* dominated in particular in area EN9 as well.

A total of 12 Red List species according to RACHOR et al. (2013) were detected, as well as *Callianassa subterranea, Upogebia deltaura* and *Upogebia stellata,* three species of burrowing soil megafauna. *Upogebia stellata is* considered critically endangered (Red List category 2) and the *Icelandic* mussel *Arctica islandica* endangered (Red List category 3).

Due to the presence of species of burrowing bottom megafauna, the benthic community in the area of site EN9 is assigned an average to above-average importance.

Priority areas for wind energy EN7, EN8, EN10, EN11, EN12 and EN13

In the area of areas EN7 and EN8 as well as EN10 to EN12, the geo-cluster NW DB I (Northwest German Bight I) was identified by DANNHEIM et al. (2014a). These offshore areas are mainly characterised by the mussel *Nucula nitidosa* and the polychaetes *Nepthys hombergii.*

The benthic community in area EN13 is primarily the *Amphiura filiformis community* with some elements of the *Nucula nitidosa association* (IFAÖ 2015c, d). Characteristic species of these communities in the studies were mainly the brittle star *Amphiura filfiformis*, the bivalves *Mysella bidentata*, *Nucula nitidosa*, *Abra alba* and the polychaet *Scalibregma inflatum*.

The species diversity and number of Red List species can be described as average overall for the areas mentioned. Due to the ecological importance of the species of burrowing bottom megafauna detected in the surveys of the areas in each case, the benthos in these areas has an overall average to above-average importance.

With regard to the description of the benthic communities in the area of site EN7, the results of the benthic surveys from 2002 to 2010 can be used. Essentially, area EN7 is a transitional community of the *Nucula nitidosa community* with the adjacent *Tellina fabula association to the* south and the *Amphiura filiformis community to* the north. These communities are widespread in the North Sea EEZ and are not threatened.

The species diversity of the infauna in the southern part of area EN7 comprised 122 taxa, with the Polychaeta being the most species-rich, followed by the Crustacea and the Mollusca. The most dominant species was the nut clam *Nucula nitidosa*. Other dominant species were the polychaet *Nepthys hombergii* and the mussel *Corbula gibba*. The biomass was determined by the heart sea urchin *Echinocardium cordatum* and the tower snail *Turritella communis.* Of the two species of burrowing soil megafauna, *Callianassa subterranea* was found relatively frequently, whereas *Upogebia deltaura was* only found in small numbers.

Due to the occurrence of species of burrowing bottom megafauna, the benthic community in the area of site EN7 is assigned an average to above-average importance. The species diversity and number of Red List species in this area is considered average.

The benthos in the area of site EN8 and thus also in site N-8.4 can be assigned to the *Amphiura filiformis community,* but also shows elements of the *Nucula nitidosa association.* Between 146 and 169 taxa of the benthic infauna and 22 to 38 taxa of the benthic epifauna were recorded in the area of site EN8 (IFAÖ 2016, BIOCONSULT 2018). Dominant species in terms of abundance were mainly the brittle star *Amphiura filiformis*, the mussels *Nucula nitidosa* and *Corbula gibba* and the horseshoe worm *Phoronis* spp. The biomass was mainly dominated by the heart sea urchin *Echinocardium cordatum* and the tower snail *Turritella communis.*

So far, 23 to 31 species of the infauna and between 16 and 23 species of the epifauna, which are considered endangered or rare according to the Red List of RACHOR et al. (2013), have been detected in area EN8. The mussels *Ensis ensis* and *Mya truncata*, the whelk *Buccinum undatum, the* polychaet *Sabellaria spinulosa* and the mole crab *Upogebia stellata were sporadically* recorded as severely endangered (Red List category 2). Furthermore, the Iceland mussel *Arctica islandica*, which is considered endangered (Red List category 3), the polychaet *Sigalion mathildae* and the mud rose *Sagartiogeton undatus* also occurred in low abundance in area EN8. Four species of burrowing soil megafauna, *Callianassa subterranea*, *Upogebia deltaura, U. stellata* and *Nephrops norvegicus,* were detected, although only the species *Callianassa subterranea,* which is considered to be endangered, was detected in higher abundances.

Due to the average species diversity, an above-average number or abundance of Red List species as well as the occurrence of several species of burrowing bottom megafauna, the importance of the benthos in area EN8 is rated as average to above average.

Reserved areas for wind energy EN14 to EN18

In the area of sites EN14 to EN18 (shipping route 10 and southern area of the duckbill), the primary *community* identified by DANNHEIM et al. (2014a) is *Amphiura filiformis*, which is widespread on silty sands of the North Sea EEZ. In the north-eastern area of EN16, or in the designated reserved area for *Nephrops* fisheries (FiN1), burrowing bottom megafauna (e.g. *Nephrops norvegicus* and *Callianassa subterranea*) are known to occur and this area is considered to be the traditional main area for Nephrops (THÜNEN 2020).

Due to the presence of the widespread Amphiura filiformis community, the benthos in these areas has an average, and in sub-areas with occurrences of burrowing soil megafauna an above-average importance.

Reserved area for wind energy EN19

The northern area of the duckbill is characterised by the presence of two communities each of epifauna and infauna (DANNHEIM et al. 2014a). Overall, this area has a higher diversity and quality compared to the nearshore regions due to more balanced dominance ratios. However, there are lower abundances and biomasses far from the coast compared to the more productive nearshore regions (DANNHEIM et al. 2014a). According to DANNHEIM et al. (2016), the offshore area of the duckbill is characterised by a higher number of Red List species. In addition to distance from the coast, the distribution of Red List species in the German EEZ is largely determined by water depth, temperature and sediment properties, and thus does not differ significantly from the distribution patterns of the rest of the benthic fauna (DANNHEIM et al. 2016).

From the 50 m depth contour in the area of site EN19, a change in the composition of the benthic fauna takes place. This boundary corresponds to the boundary between mixed and stratified water masses and the associated strong changes in the biotic and abiotic environment, which result in a clear faunal separation (NEUMANN et al. 2008). DANNHEIM et al. (2014a) identified the benthic community of the central North Sea for this area, which had the highest number of species and highest diversity of 44 ± 9 m-2 compared to the other communities of the North Sea EEZ.

Overall, the benthos in this area is therefore of above-average importance. While the Central North Sea community is restricted to the area of site EN19 within the EEZ, it is relatively widespread outside the German EEZ.

Reserved areas for raw material extraction SKN1 and SKN2

In the reserved areas SKN1 and SKN2 for sand and gravel extraction in the area of the nature reserve "Sylt Outer Reef - Eastern German Bight", areas of species-rich gravel, coarse sand and shingle grounds are colonised by the Goniadella spisula community, coarse sand and pebble beds are colonised by the Goniadella-Spisula community with the eponymous species Goniadella bobretzkii and Spisula subtruncata as well as the typical representatives *Aonides paucibranchiata, Branchiostoma lanceolatum, Ophelia limacina, Polygordius* spp., *Goodallia triangularis* and *Protodorvillea kefersteini* (IFAÖ 2019a). In these areas, the benthos are of above-average importance.

2.7 Fish

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

For a first subdivision of the fish fauna, the way of life of the adults is useful. Bottom-dwelling (demersal) species can be distinguished from those that live in open water (pelagic). Mixed forms of these (benthopelagic) are also widespread. However, this separation is not strict: demersal fish regularly ascend into the water column, pelagic fish occasionally stay near the bottom. At almost 60%, demersal fish make up the largest proportion in the North Sea, ahead of pelagic (20%) and benthopelagic (15%) species. Only about 5% cannot be assigned to any of the three life stages due to a close habitat connection (FROESE & PAULY 2000). The individual life stages of the species often differ more from each other in form and behaviour than the same stages of different species: the pelagic herring lays its eggs in thick mats on sandy-gravelly bottoms or sticks them to suitable substrate such as algae or stones (DICKEY-COLLAS et al. 2015), all flatfish have pelagic larvae that metamorphose into the characteristic body shape to become bottom-dwelling (VELASCO ET AL. 2015), and benthopelagic fish such as cod have pelagic eggs and larvae (HISLOP et al. 2015). The vast majority of fish species recorded in the North Sea complete their entire life cycle there, from egg to spawning adult, and are therefore considered *permanent residents* (LOZAN 1990). They include commercially fished species such as sand eel, mackerel or sole, as well as economically insignificant species such as eelpout or lemon sole.

Other marine species occur regularly in the North Sea as so-called "summer visitors", mainly in summer, but without clear signs of reproduction. Examples are the red gurnard and the striped mullet. However, very small juveniles of these two species have been recorded recently, suggesting reproduction in the area (HEESSEN 2015, DÄNHARDT 2017).

Some species occur irregularly in the North Sea regardless of the season, including sea cat, bream mackerel, dogtooth and halibut. Only single specimens of these and other so-called "stray guests" are usually caught.

Unlike the marine fish of the above three categories, the life cycle of diadromous species spans the sea and freshwater. As the only so-called catadromous species found in the German EEZ, the eel spawns in the sea and spends most of its adult life in fresh or brackish water. Much more common are anadromous species that spawn in freshwater and otherwise live in the sea. In the EEZ, smelt, finfish and sea lamprey are examples of this.

The most important influences on fish populations are fisheries and climate change (HOLLOWED et al. 2013, HEESSEN et al. 2015). The current warming of the North Sea may lead to a weakening of the synchronicity between temperature-controlled zooplankton development and daylength-controlled phytoplankton development. Due to this "mismatch" (CUSHING 1990, BEAUGRAND et al. 2003), fish larvae may find a reduced density of zooplankton when they depend on external food after consuming their yolk sac. The importance of this phenomenon stems from the fact that across species, survival rates of early life stages have a disproportionate effect on population dynamics (HOUDE 1987, 2008). This variability can propagate to predators at the top of the food web (DURANT et al. 2007, DÄNHARDT & BECKER 2011) and has implications for fish stock management.

Effects of fisheries and climate change interact and can hardly be distinguished in their relative impact on fish population dynamics (DAAN et al. 1990, VAN BEUSEKOM et al. 2018). Thus, although dominance relationships within a fish species community may follow long-term, periodic climate fluctuations (PERRY et al. 2005, BEAUGRAND 2009, GRÖGER ET AL. 2010, HISLOP ET AL. 2015). However, these cannot be explained without taking fisheries into account (FAUCHALD 2010). Despite their complexity, a holistic view of the effects of various stressors on the fish fauna offers the possibility of recognising negative effects at an early stage and, if necessary, introducing targeted measures.

2.7.1 Data situation

As data are almost exclusively available from bottom trawling, but not from pelagic sampling, the following assessment can only be made for demersal fish. For pelagic fish, no data are available that fully represent the species spectrum and were collected in connection with offshore wind farms. A reliable assessment of the pelagic fish community is therefore not possible. The bases for the assessment of the status of (bottom-dwelling) fish are as follows

- the analyses of the R & D project "Assessment approaches for spatial planning and approval procedures with regard to the benthic system and habitat structures" (Dannheim ET al., 2014).
- current (as of 2014) results from environmental impact studies and cluster studies for the preparation of current species lists (only areas N-1 to N-8).
- the International Council for the Exploration of the Sea (ICES) trawl survey database (DATRAS) (accessed 12 March 2018). Here, only the standard areas and plan squares covering the German EEZ of the North Sea were considered. In the standard round fish area 6, these are the plan squares 37F6, 38F5-F8, 39F5 and 40F4-F7. The catch data from the 1st and 3rd quarters of the most recent year (2017) were combined. For 2018, data from the 1st quarter were already available; these were combined with the data from the 3rd quarter of 2017.

It has to be taken into account that the supplementary DATRAS data were carried out with different fishing gear as well as deviating haul numbers and towing times compared to the investigations of the environmental impact studies and cluster investigations. For a historical reference, EHRICH et al. (2006) and KLOPPMANN et al. (2003) were considered. For a North Sea-wide context, HEESSEN et al. (2015) were used. For the current assessment (2017/2018) of the exploited stocks, the internet portal "Fish stocks online" (BARZ & ZIMMERMANN 2018) was used, which clearly summarises the scientific stock assessment of ICES.

2.7.2 Spatial distribution and temporal variability

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 set by many different factors that take effect at different spatial and temporal scales. On a large scale, hydrographic and climatic factors such as swell, tides and wind-induced currents as well as the large-scale circulation of the North Sea have an effect. On a medium (regional) to small (local) space-time scale, water temperature and other hydrophysical and hydrochemical parameters have an effect, as do food availability, intra- and interspecific competition and predation, which also includes fishing. Another crucial factor for the distribution of fish in time and space is habitat, which in a broader sense means not only physical structures but also hydrographic phenomena such as fronts (MUNK et al. 2009) and upwelling areas (GUTIERREZ et al. 2007), where prey can aggregate and thus initiate and maintain entire trophic cascades.

The diverse human activities and influences are further factors that structure fish distribution. They range from nutrient and pollutant discharges to the shoring of migratory routes of migratory species and fisheries to constructions in the sea. Newly introduced structures can serve as spawning substrate (sheet piling for herring spawning) or food source (fouling of artificial structures) for some fish species (EEA 2015). Some fish species, such as cod, aggregate on artificial structures (e.g. GLAROU et al. 2020). In addition, with the exception of the vehicles required to operate the wind farm (maintenance vessels), a general prohibition of navigation and use is regularly provided within the OWP areas, with the consequence that no fishing takes place in the area. There is a need for research to determine whether the fish community uses the fishery-free area as a refuge. Further information on the effects of newly introduced structures is described in Chapter 3.2.3

2.7.2.1 Red List species in the German North Sea area

For the 107 species of fish and lamprey established in the North Sea, the Red List assessed the endangerment based on the current population situation as well as long-term and short-term population trends (THIEL et al. 2013). According to this, 23.4% (25 species) of the marine fish and lampreys established in the North Sea are classified as extinct or threatened. Taking into account the extremely rare species, the proportion of Red List species increases to 27.1% (29 species). Five of these species (Alse, Finte, Nordseeschnäpel, Fluss- und Meerneunauge) are additionally listed in Annex II of the Habitats Directive.

As part of a research and development project, DANNHEIM et al. (2014) derived "assessment approaches for spatial planning and approval procedures with regard to the benthic system and habitat structures" from data from 30 wind farm projects and nine research projects of the Alfred Wegener Institute for Polar and Marine Research. According to this, 15 of the 89 analysed fish species (16.9%) had a Red List endangerment status: Allis shad, thornback ray and spiny dogfish are threatened with extinction (category 1), European eel, dogfish and haddock are considered critically endangered (category 2), while finfish, starry stingray, river lamprey, greater petrale and dwarf cod are endangered (category 3). For great snake needle, ling and great pipe needle, the authors found endangerment of unknown extent (category G), and the spotted wrasse is extremely rare (category R).

2.7.2.2 Regionally typical fish communities in the EEZ

KLOPPMANN et al. (2003) detected a total of 39 fish species during a one-off survey to record FFH Annex II fish species in the German EEZ in the areas of Borkum-Riffgrund, Amrum-Außengrund, Osthang Elbe-Urstromtal and Doggerbank in May 2002. In this study, they identified a gradual change in the species composition of the fish communities from the nearshore to the offshore areas due to hydrographic conditions. These changes were confirmed by DANNHEIM et al. (2014), who were able to geographically distinguish four fish communities in the German EEZ based on effort-corrected catch numbers: The largest formed the central community (ZG), which could be delimited in the north by the two duckbill communities (ES I and ES II) and along the coast by a coastal community (KG) (Figure 38and Figure 40). Areas with less than six stations were not assigned to any fish community (grey symbols in Figure 38).

The four identified fish communities basically showed a similar species composition, but with different, species-specific abundances. Dab generally dominated and occurred very regularly, while plaice and dab predominated in the offshore community ES II. Plaice were also found regularly in the central transitional community. Lyrefish, and rock pickerel were characteristic of the inshore demersal community. Lesser sole and lyrefish were also regularly found in the central transitional community. The species composition and distribution of demersal fish showed gradual changes from offshore to central community to nearshore areas. The species number of community ES I was significantly lower (ES I: 2 ± 1 * Hol-1) than that of the other communities with a mean species number of 6 ± 2 Hol-1 (ES II) and 7 ± 2 * Hol-1 (KG), respectively.

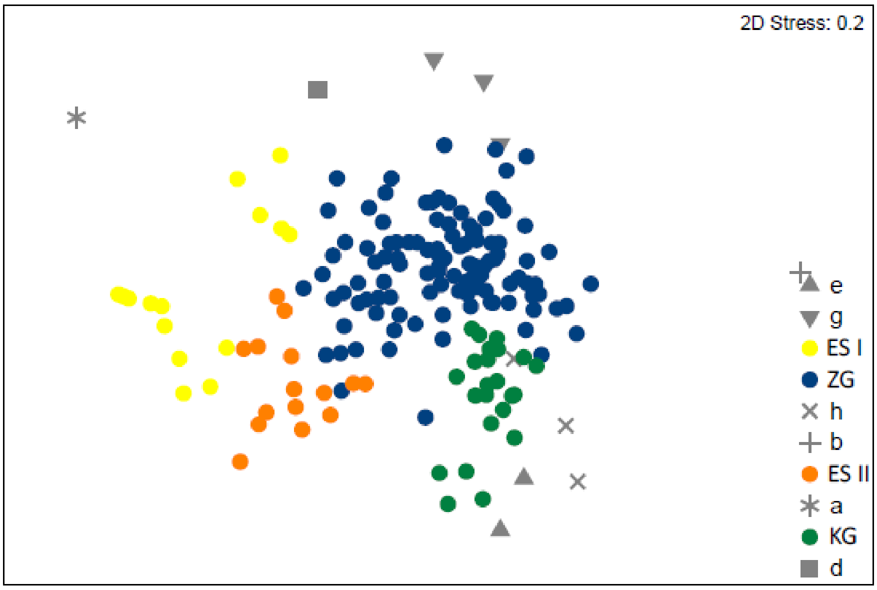


Figure 31: Relative similarity of species composition and species-specific abundances of bottom-dwelling fish in the German EEZ of the North Sea. The central community (ZG, blue dots), the coastal community (KG, green dots) and two duckbill communities (ES I & II, yellow and orange dots) can be clearly delineated. Areas with less than six stations were not assigned to any fish community (grey symbols e, g, h, b and d). Non-metric multidimensional scaling based on √-transformed and effort-normalised abundance data from catches with a 2 m beam trawl; N = 173 stations). From DANNHEIM et al. (2014).

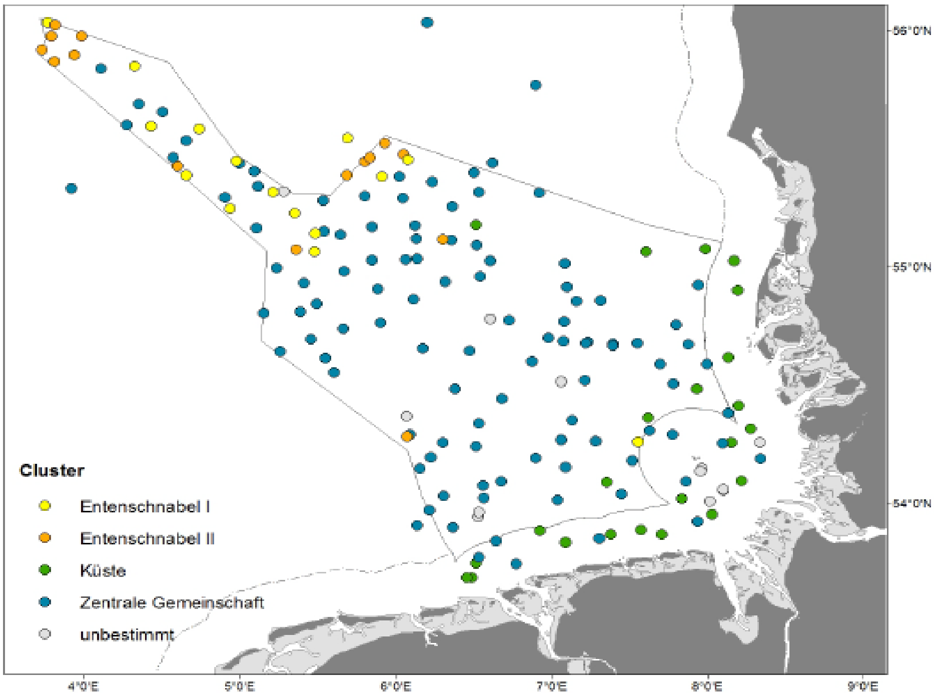


Figure 32: Map of the spatial variability of the identified fish communities of the German EEZ of the North Sea based on effort-corrected abundance data. Abbreviations, analysis methods, colour coding and sample size as in Figure 38. From DANNHEIM et al. (2014).

Like the number of species, the abundance of demersal fish increased with proximity to the coast, from 4,454 ± 3,598 individuals * km-2 in ES I far from the coast to 95,128 ± 44,582 individuals * km-2 in the coastal community (Figure 41). Biomass, on the other hand, showed no directional geographic trend, with the lowest biomass also found in ES I (108 ± 112 kg * km-2). The highest biomass was found in ES II with 801 ± 513 kg * km-2 (Figure 41).

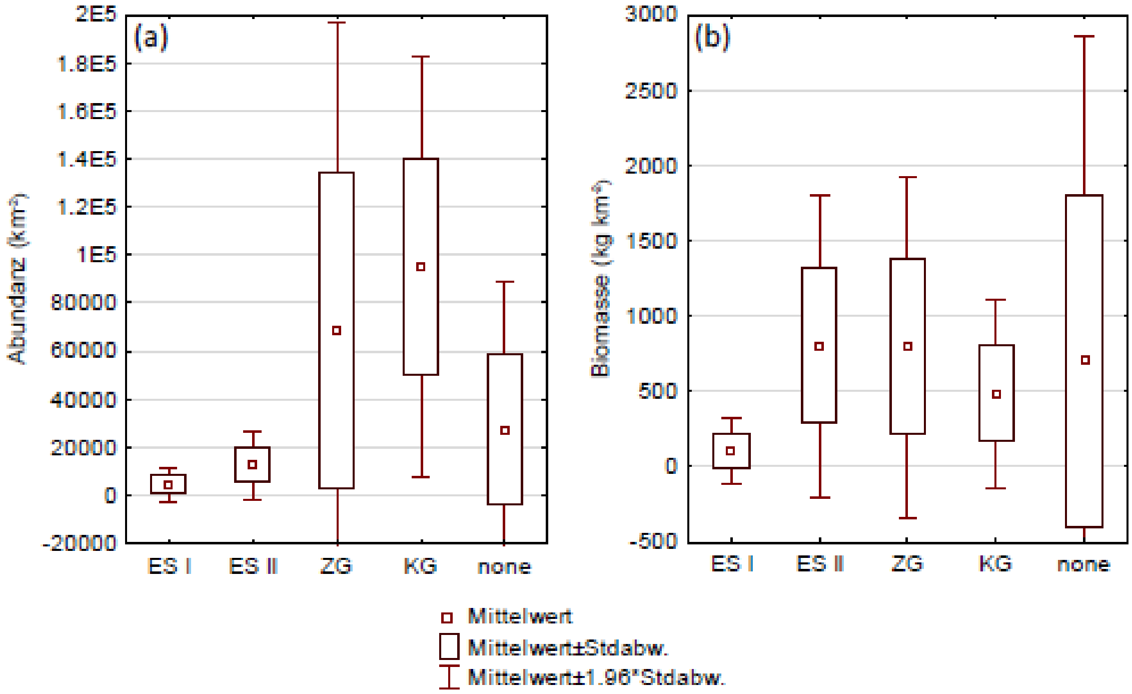


Figure 33: Box-Whisker plots of (a) abundance (individuals * km-2) and (b) biomass (kg * km-2) of the identified fish communities in the German EEZ of the North Sea. Abbreviations, analytical methods and sample sizes as in Figure 38. From DANNHEIM et al. (2014).

Based on high-resolution data from environmental impact studies for individual offshore wind farms, the demersal fish community was investigated on a smaller scale (DANNHEIM et al. 2014). For this purpose, the data for the community analyses were grouped according to wind farm clusters as defined in the Bundesfachplan Offshore (BSH 2017). In the following, these wind farm areas are referred to numerically as OWF areas 1-12 (Figure 43below). In order to exclude temporal effects on the spatial analyses, data from all OWF areas were evaluated in pairs separately by year and season (Figure 43top left). The individual OWF areas were compared with each other in pairs using one-factor similarity analyses (ANOSIM), with the mean R-value calculated as a measure of the mean dissimilarity between predefined groups (here: the OWF areas). R-values close to 0 indicate an absence of differences, R-values close to 0.25 state that groups are almost inseparable, R-values close to 0.50 indicate that separation of groups is possible, R-values close to 0.75 indicate good separability of groups, while finally R-values close to 1.00 mark complete separation of groups (CLARKE & GORLEY 2001). Without the influence of temporal effects, the western OWF areas 1 and 2 (SW-W DB) could be separated from the eastern OWF area 3 (SW-O DB) in the southwestern German Bight off the East Frisian coast

(Figure 43). Furthermore, the analyses showed a separation of the coastal OWF areas 4 (S EUT) and 5 (N EUT) along the edge of the Elbe River valley. The greatest similarity (marked by low R-values) in terms of species-specific fish abundance was between OWF areas 6 to 12 in the northwestern German Bight (NW DB).

The differences between the five geo-clusters identified using ANOSIM (SW-W DB, SW-O DB, N EUT, S EUT, NW DB (Figure 43) stood out clearly, with the degree of dissimilarity sometimes differing greatly even between neighbouring geo-clusters. While OWF areas 5 and 6 were very similar (mean R-value=0.42), the fish community of OWF area 12 differed significantly from that of OWF area 10 within the NW DB geocluster (R=0.84) (Figure 43top left). The separation of the geoclusters based on species-specific abundance should therefore be understood as a spatial gradient in community expression rather than a sharp demarcation of different demersal fish communities. The number of species of demersal fish was basically very similar between the geo-clusters: In the SW-W DB geo-cluster, the most species per haul were caught on average (13 ± 3), while the fewest fish species (11 ± 3) were found in the N EUT geo-cluster. Furthermore, the geo-clusters did not show geographically clear differences in total abundance and total biomass of all species. The highest abundance was recorded in the SW-O DB geo-cluster (82,040 ± 70,335 individuals * km-2), the lowest in the NW DB geo-cluster (20,010 ± 22,847 individuals * km-2). The average biomass varied between 750 ± 447 kg * km-2 (NW DB) and 1563 ± 657 kg * km-2 (SW-O DB). The species composition also hardly differed between the geo-clusters: Over 60% of the species occurred across areas. Only five species were relevant to dissimilarity between geo-clusters. Lamb's tongue, dab and plaice occurred in all geo-clusters, but they contributed to similarity to varying degrees. Lamb's tongue was characteristic of the western geo-clusters (SW-W DB, SW-O DB, NW DB), while gobies characterised the geo-clusters along the Elbe River valley or eastern areas (N EUT, S EUT). There are hardly any structural differences in species composition between the geo-clusters. Differences are based solely on the different abundances of the species.

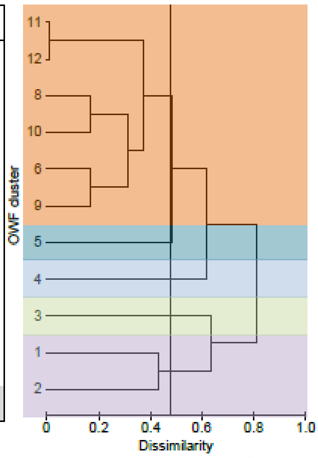
2.7.3 Assessment of the status of fish as a protected resource

The status assessment of the demersal fish community of the EEZ of the German North Sea is based on i) rarity and vulnerability, ii) diversity and distinctiveness, and iii) pre-existing pressure. These three criteria are defined below and applied separately for Areas 1-3, for Area 4, for Area 5, for Areas 6-8 and for Areas 9-13.

Rarity and endangerment

The rarity and endangerment of the fish community is assessed by the proportion of species that are considered endangered according to the current Red List of Marine Fishes (THIEL et al. 2013) and for the diadromous species of the Red List of Freshwater Fishes (FREYHOF 2009) and have been assigned to one of the following Red List categories: Extinct or Missing (0), Critically Endangered (1), Endangered (2), Endangered (3), Endangerment of Unknown Extent (G), Extremely Rare (R), Forewarned List (V), Insufficient Data (D) or Endangered (*) (THIEL et al. 2013). The endangerment situation of species listed in Annex II of the Habitats Directive requires special attention. They are the focus of Europe-wide conservation efforts and require special protection measures, e.g. of their habitats.

Cluster	1	2	3	4	5	6	8	9	10	11	12
1		0,43	**0,60**	**0,77**	**0,67**		**0,80**				
2			**0,67**	**0,77**	**0,60**	**0,78**	**0,79**	**0,96**	**0,93**	**0,85**	**1,00**
3				**0,69**	**0,68**	**0,76**	**0,71**	**0,97**	**0,95**	**0,89**	
4					**0,54**		**0,70**				
5						0,42	**0,55**				
6							0,24	0,17	0,22	0,21	
8								0,47	0,17	0,10	0,37
9									0,34	0,49	
10										0,21	**0,84**
11											0,01
12											



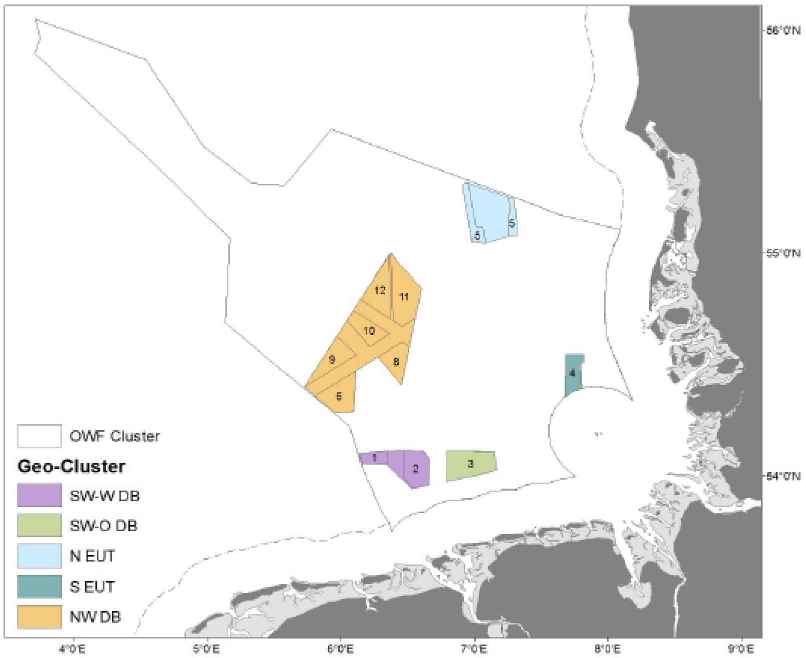


Figure 34: Top: R-values for OWF area difference (single factor ANOSIM) based on demersal fish abundance data. The R-values correspond to the mean R-value of the individual pairwise tests between the OWF areas. Top: Differences between identified geo-clusters in different colours. Bottom: Map of OWF areas (numbers) and location of geo-clusters identified from R-values (single factor ANOSIM) (colours, see map legend). SW-W DB: western Southwest German Bight, SW-O: eastern Southwest German Bight, N EUT: Northern Elbe River Valley, S EUT: Southern Elbe River Valley, NW DB: Northwest German Bight. From DANNHEIM et al. (2014).

A total of 37 fish species were identified in the lake areas in which **areas EN1, EN2 and EN3 are** located during the environmental impact assessments and in the course of fish monitoring for stock assessment in the above-mentioned period (Chapter 2.7.1). Of these, according to THIEL et al. (2013), no species is considered extinct or lost (0), the thornback ray *Raja clavata* (1 species, 2.7%) is threatened with extinction (1), and no highly endangered species (2) were detected. The Great Petrel *Trachinus draco is* considered endangered (3) (1 species, 2.7 %). The large pinniped *Syngnathus acus* and the large snake pinniped *Entelurus aequoreus are* considered to be at risk of unknown magnitude (G) (2 species, 5.4 %). None of the species recorded in areas EN1-EN3 is extremely rare (R), while mackerel *Scomber scombrus*, turbot *Scophthalmus maximus* and *sole Solea solea are* on the forewarned list (3 species, 8.1%). For the lesser sandeel *Ammodytes marinus*, the ornamental eggfish *Callionymus reticulatus, the* large spotted sandeel *Hyperoplus lanceolatus*, the spotted goby *Pomatoschistus pictus* and the sea bull *Taurulus bubalis* (5 species, 13.5%), the data situation is considered insufficient for an assessment (D). Of the 37 species recorded, 25 (67.6%) are considered to be endangered (*), including the three-spined stickleback *Gasterosteus aculeatus,* which was assessed in the Red List of Freshwater Fishes (FREYHOF 2009) (Table 9).

In the lake areas where **area EN4 is** located, a total of 37 species were identified during the environmental impact assessments and fish monitoring for stock assessment, of which no species is considered extinct or lost (0), threatened with extinction or critically endangered (2) according to THIEL et al. (2013). One species, the starry stingray *Amblyraja radiata*, is considered endangered (3) (1 species, 2.7%). For the great snake needle *Entelurus aequoreus, there is an* endangerment of unknown extent (G) (1 species, 2.7%), while smelt *Osmerus eperlanus (*assessed in FREYHOF 2009), mackerel *Scomber scombrus*, turbot *Scophthalmus maximus* and *sole Solea solea are* on the forewarned list (4 species, 10.8%). For another three species (8.1%), the lesser sandeel *Ammodytes marinus*, the ornamental eggfish *Callionymus reticulatus* and the greater spotted sandeel *Hyperoplus lanceolatus, the* available data are insufficient for an assessment (D). 28 species (75.7%) are considered to be threatened (*) (Table 9).

In the lake area where **site EN5 is** located, a total of 35 species were identified during the environmental impact assessments and the fish monitoring for stock assessment. According to THIEL et al. (2013), none of these species is considered extinct or lost (0), threatened with extinction (1), critically endangered (2) or extremely rare (R). Likewise, none of the species found in area EN5 is at risk of unknown extent (G). FREYHOF (2009) estimates the river lamprey *Lampetra fluviatilis* as endangered (3) (2.9%), and as in the areas already discussed, mackerel *Scomber scombrus*, turbot *Scophthalmus maximus* and *sole Solea solea are on the* forewarned list (3 species, 8.6%). The data situation for the lesser sandeel *Ammodytes marinus*, the *tobias* fish *Ammodytes tobianus*, the ornamental eggfish *Callionymus reticulatus* and for the greater spotted sandeel *Hyperoplus lanceolatus* is considered insufficient, and 27 species (77.1%) are considered to be threatened (*) (Table 9).

In the lake areas where **sites EN6-EN8 are** located, a total of 39 species were identified during the environmental impact assessments and fish monitoring for stock assessment. Of these, according to THIEL et al. (2013), no species is considered extinct or lost (0), the thornback ray *Raja clavata* (1 species, 2.6%) is threatened with extinction (1). The European eel *Anguilla anguilla* and the dogfish *Galeorhinus galeus* (2 species, 5.1%) are critically endangered (2), the starry ray *Amblyraja radiata* and the finback *Alosa fallax are classified as* endangered (3) (2 species, 5.1%), while the great needle *Syngnathus acus is classified as* threatened to an unknown extent (G) (1 species, 2.6%). The spotted ray *Raja montagui* (1 species, 2.6%) is extremely rare (R), mackerel *Scomber scombrus*, turbot *Scophthalmus maximus* and *sole Solea solea are on the* forewarned list (V) (3 species, 7.7%). For the lesser sandeel *Ammodytes marinus* and the greater spotted sandeel *Hyperoplus lanceolatus, the* available data are insufficient for an assessment (D) (2 species, 5.1%), 27 species (69.2%) are considered to be threatened (*) (Table 9).

In the lake areas where **sites EN9-EN13 are** located, no environmental impact assessments have been carried out so far. The assessment is therefore based solely on fish monitoring data for stock assessment, thus on a smaller number of hauls, which may influence the number of species. A total of 29 species were found in areas EN9-EN13, none of which are considered extinct or lost (0), critically endangered (2), extremely rare (R) or at risk of unknown magnitude (G) according to THIEL et al. (2013). The spiny dogfish *Squalus acanthias* is threatened with extinction (1) (1 species, 3.4%), the starry ray *Amblyraja radiata is considered* endangered (3) (1 species, 3.4%). As in all other clusters considered, mackerel *Scomber scombrus*, turbot *Scophthalmus maximus* and *sole Solea solea are* on the forewarned list (3 species, 10.3%). For the lesser sandeel *Ammodytes marinus*, the greater spotted sandeel *Hyperoplus lanceolatus* and for the hake *Merluccius merluccius, the* available data are insufficient for an assessment (D) (3 species, 13.8%). 20 species (69%) are considered to be threatened (*) (Table 9).

Table 9: Relative proportion of Red List categories in fish species detected in Areas 1-3, 4, 5, 6-8 and 9-13. Extinct or lost (0), threatened with extinction (1), critically endangered (2), endangered (3), endangerment of unknown extent (G), extremely rare (R), forewarned list (V), data insufficient (D) or endangered (*) (Thiel et al. 2013). (EIS data from 2014 for clusters 1-8 and 2017/2018 data from ICES DATRAS database, see 2.8.1). For comparison, the relative proportions of the assessment categories of the Red List North Sea (Thiel et al. 2013) are shown.

Area	Red List Category								
	0	1	2	3	G	R	V	D	*
1-3	0	2,7	0	2,7	5,4	0	8,1	13,5	67,6
4	0	0	0	2,7	2,7	0	10,8	8,1	75,7
5	0	0	0	2,9	0	0	8,6	11,4	77,1
6-8	0	2,6	5,1	5,1	2,6	2,6	7,7	5,1	69,2
9-13	0	3,4	0	3,4	0	0	10,3	13,8	69
North Sea (Thiel et al. 2013)	**2,8**	**7,5**	**6,5**	**1,9**	**4,7**	**3,7**	**6,5**	**22,4**	**43,9**

In the Red List of Marine Fishes, 27.1% of the assessed species were assigned to an endangerment category (0, 1, 2, 3, G or R), 6.5% are on the forewarned list, for 22.4% no assessment is possible due to lack of data. A total of 43.9% of the species are considered to be threatened (THIEL et al. 2013) (Table 9). In comparison, significantly fewer species with an endangered status were found in all the clusters considered (1-3: 10.8%, 4: 5.4%, 5: 2.9%, 6-8: 18.0%, 9-13: 6.8%), while there were always significantly more non-endangered species than those listed in the Red List (1-3: 67.6%, 4: 75.7%, 5: 77.1%, 6-8: 69.2%, 9-13: 69.0%).

Extinct or lost species (category 0) were not found in any of the areas. For endangered (1) and critically endangered (2) species, the importance of the areas is below average, while endangered species (3) were relatively more common in all areas than in the Red List. For these species, the areas have an above-average importance. In areas EN1-EN3, a higher proportion of category G species (endangerment of unknown extent) was found, otherwise their relative proportion was below the Red List, as was that of extremely rare species (R). Relatively more species of the categories V (forewarned list) and * (endangered) were found in all areas, which thus have an above-average importance for species of these two categories. The proportion of species not assessable for lack of data (D) was clearly below the proportion of this category in the Red List in all areas (Table 9). A total of two species protected under the Habitats Directive and the Protected Area Ordinance on the "Sylt Outer Reef - Eastern German Bight" were found in the areas EN6-EN8, namely the Common Finch *Alosa fallax* and the River Lamprey Lampetra *fluviatilis* (area EN5), albeit as single catches, from which the importance of these areas for the species cannot be deduced.

Against this background, the rarity and endangerment of the fish fauna in the areas under consideration is assessed as average to above average.

Diversity and Character

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 distinctiveness of a fish community, i.e. how regularly habitat-typical species occur. Diversity and species richness are compared and assessed below between the entire North Sea and the German EEZ as well as between the EEZ and the individual areas.

In the North Sea, more than 200 fish species have been recorded so far (DAAN 1990: 224, LOZAN 1990: >200, Fricke ET al. 1994, 1995, 1996: 216, Froese & Pauly 2000: 209). By far the majority are rare individual records. Less than half of them reproduce regularly in the German EEZ or are found as larvae, juveniles or adults. According to these criteria, only 107 species are considered established in the North Sea (THIEL et al. 2013). In the International Bottom Trawl Survey (IBTS), 99 fish species were recorded in the entire North Sea between 2014 and 2018. In the German EEZ, represented here by area-based fish data from environmental impact studies (from 2014) and the DATRAS database of ICES (IBTS data 2017 & 2018), a total of 56 species were detected. With the exception of sites EN9-EN13, the number of species in each site ranged closely between 35 and 39 (see "Rarity and vulnerability"). Most species were found in areas EN6-EN8, followed by areas EN4, EN1-EN3 and EN5. In Area EN9-EN13 in Zone 3, only 29 species were recorded (Table 10), but this could be at least partly due to the lower recording effort in this area.

All typical demersal flatfish and roundfish species were detected across the area. The constant and characteristic flatfish species lamb's tongue *Arnoglossus laterna*, lemon *sole Buglossidium luteum,* dab *Limanda limanda,* lemon sole *Microstomus kitt*, plaice *Pleuronectes platessa,* turbot *Scophthalmus* maximus, brill *Scophthalmus rhombus* and *sole Solea solea* were present in all areas considered. Flounder *Platichthys flesus* were caught in 4 out of 5 areas despite their coastal and estuarine affinity (Table 10).

Although the bottom trawls used are unsuitable for detecting pelagic fish, the species typical of the pelagic part of the fish community, namely herring *Clupea harengus,* mackerel *Scomber scombrus,* sprat *Sprattus sprattus* and wood mackerel *Trachurus trachurus, were* detected in all areas (Table 10).

Table 10: Total species list of fish species detected Areas 1-3, 4, 5, 6-8 and 9-13 (EIS data from 2014 for Areas 1-8 and 2017/2018 data from ICES DATRAS database).

		CLUSTER				
Artname	Deutscher Trivialname	1, 2 & 3	4	5	6, 7 & 8	9-13
Agonus cataphractus	Steinpicker	x	x	x	x	
Alosa fallax	Finte				x	
Amblyraja radiata	Sternrochen	x	x		x	x
Ammodytes marinus	Kleiner Sandaal		x	x	x	x
Ammodytes tobianus	Tobiasfisch			x		
Anguilla anguilla	Europäischer Aal				x	
Arnoglossus laterna	Lammzunge	x	x	x	x	x
Belone belone	Hornhecht		x		x	
Buglossidium luteum	Zwergzunge	x	x	x	x	x
Callionymus lyra	Gestreifter Leierfisch	x	x	x	x	x
Callionymus reticulatus	Ornament-Leierfisch	x	x	x		
Chelidonichthys lucernus	Roter Knurrhahn	x	x	x	x	x
Ciliata mustela	Fünfbärtelige Seequappe			x		
Clupea harengus	Hering	x	x	x	x	x
Dicentrarchus labrax	Wolfsbarsch		x			
Echiichthys vipera	Vipernqueise (=Kleines Petermännchen)	x	x	x	x	x
Enchelyopus cimbrius	Vierbärtelige Seequappe	x	x		x	x
Engraulis encrasicolus	Sardelle		x	x	x	x
Entelurus aequoreus	Große Schlangennadel	x	x		x	x
Eutrigla gurnardus	Grauer Knurrhahn	x	x	x		
Gadus morhua	Kabeljau	x	x	x	x	x
Galeorhinus galeus	Hundshai				x	
Gasterosteus aculeatus	Dreistachliger Stichling	x	x	x	x	
Hippoglossoides platessoides	Doggerscharbe		x		x	x
Hyperoplus lanceolatus	Gefleckter großer Sandaal	x	x	x	x	x
Lampetra fluviatilis	Flussneunauge			x		
Limanda limanda	Kliesche	x	x	x	x	x
Liparis liparis	Großer Scheibenbauch			x		
Merlangius merlangus	Wittling	x	x	x	x	x
Merluccius merluccius	Seehecht					x
Microstomus kitt	Limande	x	x	x	x	x
Mullus surmuletus	Streifenbarbe	x	x	x	x	x
Myoxocephalus scorpius	Seeskorpion	x	x	x	x	x
Osmerus eperlanus	Stint		x			
Pholis gunnellus	Butterfisch	x	x			
Platichthys flesus	Flunder	x	x	x	x	
Pleuronectes platessa	Scholle	x	x	x	x	x
Pomatoschistus minutus	Sandgrundel	x	x	x	x	
Pomatoschistus pictus	Strandgrundel	x				
Raja clavata	Nagelrochen	x			x	
Raja montagui	Fleckrochen				x	
Sardina pilchardus	Sardine			x	x	
Scomber scombrus	Makrele	x	x	x	x	x
Scophthalmus maximus	Steinbutt	x	x	x	x	x
Scophthalmus rhombus	Glattbutt	x	x	x	x	
Scyliorhinus canicula	Kleingefleckter Katzenhai	x			x	x
Solea solea	Seezunge	x	x	x	x	x
Sprattus sprattus	Sprotte	x	x	x	x	x
Squalus acanthias	Dornhai					x
Syngnathus acus	Große Seenadel	x			x	
Syngnathus rostellatus	Kleine Seenadel	x	x	x		
Syngnathus typhle	Grasnadel			x		
Taurulus bubalis	Seebull	x				
Trachinus draco	Großes Petermännchen	x				
Trachurus trachurus	Holzmakrele (=Stöcker)	x	x	x	x	x
Zeus faber	Heringskönig (=Petersfisch)		x			x
	Anzahl Arten	37	38	35	39	29

Of the 56 species detected in the German EEZ during the observation period, only 19 species occurred in all areas, 10 species were found in four areas, 5 species were detected in three areas, 6 species only in two areas (Table 10). The remaining 16 species were each caught in only one area, with anadromous species such as feint *Alosa fallax*, river lamprey *Lampetra fluviatilis* or smelt *Osmerus eperlanus*, species with an affinity to the coast such as three-spined stickleback *Gasterosteus aculeatus*, flounder *Platichthys flesus* or gobies of the genus *Pomatoschistus* or species dependent on coastal habitats (seagrass beds) such as the lesser pipefish *Sygnathus rostellatus* occurred in the coastal clusters as expected. These species were absent in the offshore areas (areas 9-13). In contrast, hake *Merluccius merluccius* and spiny dogfish *Squalus acanthias* were caught exclusively in the offshore areas (Table 10).

The fish species composition obviously differs between the areas with regard to individual, rare species, while there are great similarities in the characteristic, more common species (Table 10).

Between 1982 and 2002, EHRICH et al. (2006) recorded 104 fish species in the North Sea, and KLOPPMANN et al. (2003) found 39 species with considerably less recording effort and a shorter recording period. The typical and characteristic species of both the pelagic and demersal components of the fish communities considered were also represented in all areas. Overall, the diversity and individuality can be considered average in all areas.

Preload

The southern North Sea has been intensively exploited for centuries. Fishing probably affects the natural habitat and the fish community the most. Nutrient pollution can also affect the natural habitat. In addition, fish are under other direct or indirect human influences, such as shipping traffic, pollutants, sand and gravel extraction. However, these indirect influences and their effects on fish fauna are difficult to prove. In principle, the relative impacts of the individual anthropogenic factors on the fish community and their interactions with natural biotic (predators, prey, competitors, reproduction) and abiotic (hydrography, meteorology, sediment dynamics) influencing variables of the German EEZ cannot be reliably separated. However, due to the removal of target species and bycatch, as well as the impact on the seabed in the case of bottom-dwelling fishing methods, fishing is considered to be the most effective pre-existing pressure on the fish community. An assessment of the stocks on a smaller spatial scale such as the German Bight is not carried out. Consequently, the assessment of this criterion cannot be carried out at area level, but only for the entire North Sea.

Of the 107 species considered established in the North Sea, 21 are commercially fished (THIEL et al. 2013). The fisheries impact assessment is based on the Fisheries overview - Greater North Sea Ecoregion of the International Council for the Exploration of the Sea (ICES 2018a). Fisheries have two main effects on the ecosystem: the disturbance or destruction of benthic habitats by bottom-set nets and the take of target species and bycatch species. The latter often include protected, endangered or threatened species, including not only fish but also birds and mammals (ICES 2018b). About 6600 fishing vessels from 9 nations fish in the North Sea. The largest quantities were landed in the early 1970s, since when catches have declined. However, a reduction in fishing effort has only been observed since 2003.

The intensity of bottom-targeting fisheries is concentrated in the southern North Sea and is also by far the predominant type of fishery in the German EEZ (ICES 2018a). The flatfish fishery in the German EEZ targets plaice and sole, using not only heavy bottom gears but also relatively small meshes, as a result of which bycatch rates of small fish and other marine organisms can be very high.

Commercial fisheries and spawning stock size are assessed against maximum sustainable yield (MSY), taking into account the precautionary approach. A total of 119 stocks across the North Sea were considered in terms of fishing intensity, of which 43 are assessed scientifically

(Figure 45). Of the 43 stocks assessed, 25 are sustainably managed. 38 of the 119 stocks were assessed for reproductive capacity (spawning biomass), with 29 stocks being able to utilise their full reproductive capacity (Figure 45).

The biomass share of the total catch (5,350,000 t in 2017) managed at too high a fishing intensity outweighs the shares of sustainably caught and unassessed fish stocks in the North Sea (Figure 45). Fish from stocks whose reproductive capacity is above the reference level account for the overwhelming biomass share of the catch (3,709,000 t, Figure 45).

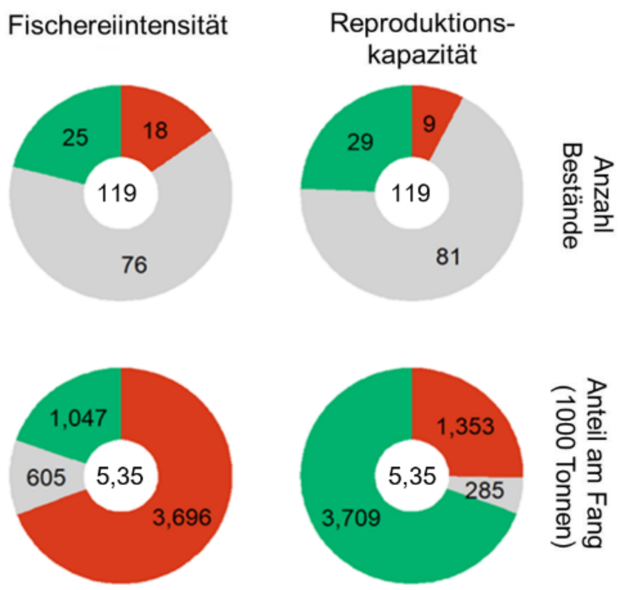


Figure 35: Summary of the status of fish stocks across the North Sea in 2017, focusing on fishing intensity and reproductive capacity. Left: Fishing intensity indicates the number of stocks (top) and the biomass share of the catch (bottom; in 1000 t) that is below (green) or above (red) the reference level (fishing intensity for sustainable yield, FMSY). Right: Reproductive capacity indicates the number of stocks (top) and the biomass fraction of the catch (bottom) that is above (green) or below (red) the reference value (-spawning biomass, MSY Btrigger). Grey indicates the number or biomass fraction of the catch of stocks for which no reference points are defined and for which no stock assessment is possible. Consideration of a total of 119 stocks. Modified according to ICES 2018a.

Overall, fishing mortality on demersal and pelagic fish has decreased significantly since the late 1990s, and for most of these stocks spawning biomass has been increasing since 2000 and is now above or close to individually set reference points. Nevertheless, fishing mortality for many stocks is also above the established reference levels, e.g. for cod *Gadus morhua*, whiting *Merlangius merlangus* or mackerel *Scomber scombrus*. In addition, no reference points have been defined for the majority of the exploited stocks, which means that a scientific stock assessment is not possible.

In addition to fishing, eutrophication is one of the greatest ecological problems for the marine environment in the North Sea (BMU 2018). Despite reduced nutrient inputs and lower nutrient concentrations, the southern North Sea is subject to a high eutrophication load in the period 2006 - 2014. Nitrates and phosphates are predominantly discharged via rivers, resulting in a pronounced gradient of nutrient concentrations 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 of seagrass areas and density with associated mass proliferation of green algae. Above all, the seagrass meadows of the Wadden Sea take on an important protective function of fish spawn and provide a shelter and feeding area for numerous young fish between the blades. As seagrass beds decline due to eutrophication, there are fewer refuges and potentially higher predation rates. The indirect effects of nutrient enrichment, such as oxygen deficiency and altered species composition of the macrozoobenthos, can also have an impact on fish fauna. The survival and development of fish eggs and larvae depends on oxygen concentration in many species (Serigstad 1987). Depending on how much oxygen is needed, oxygen deficiency can lead to the death of fish spawn and larvae. Furthermore, the altered species composition of the benthos can also influence the biodiversity of the fish community, especially that of the food specialists.

Based on the fact that, according to ICES, fish species richness in the North Sea has not declined for 40 years (number of species per 300 hauls; catch data from the International Bottom Trawl Survey, IBTS), and that commercially exploited stocks are also subject to strong natural fluctuations, the pre-existing pressure on the fish fauna in the German EEZ was assessed as average. This assessment is supported by the summary of fishery metrics and ecosystem effects of bottom trawling (WATLING & NORSE 1998, Hiddink ET al. 2006).

2.7.3.1 Importance of the areas for fish

The overriding criterion for the importance of areas for fish is the relationship to the life cycle, within which different stations with stage-specific habitat requirements are linked by more or less long migrations in between. The overview of species records by area showed no particular importance of a specific area for the steady, common character species (Table 10). However, there is a tendency for the areas closer to the coast to harbour more species. Although this could be an artefact of the different haul numbers, an overlap between the habitat of coastal fish species and the existing and future wind farm areas is quite plausible against the background of the mobile lifestyle and life cycle of most species. The higher proportion of species with affinity to the coast in the nearshore areas could therefore be an indication of a higher importance of areas EN1 to EN3, area EN4 and area EN5 for fish with affinity to the coast, such as butterfish, smelt and pipefish, than the offshore areas. Also, these areas lie along the migration route of herring that spawn along the UK east coast in autumn and winter. The larvae first reach the nearshore nursery areas with the counterclockwise residual North Sea current (DICKEY-COLLAS et al. 2009), from where they also recruit to the adult stock along the coast as one or two year old fish. Plaice spawned in the central North Sea migrate to their coastal nursery areas (BOLLE et al. 2009), passing through all of the areas considered here, which may thus be significant as transit areas for one of the most common fish species in the North Sea. The fact that dogfish were only caught in areas EN9 to EN13 may not be sufficient to establish a special importance of these areas for this species, as dogfish also occur on the coast. Slightly higher proportions of threatened, critically endangered, endangered and at unknown risk species were found in areas EN6 to EN8 than in other areas, which were also above the Red List average. For these species, this area could be of higher importance than other areas where evidence is lacking.

2.8 Marine mammals

Three species of marine mammals regularly occur in the German North Sea EEZ: Harbour porpoises (*Phocoena phocoena*), grey seals (*Halichoerus grypus*) and harbour seals (*Phoca vitulina*). All three species are characterised by high mobility. Migrations (especially for food) are not limited to the EEZ, but also include the coastal sea and large areas of the North Sea across borders.

The two seal species have their resting and littering places on islands and sandbanks in the area of the coastal sea. To search for food, they undertake extensive migrations in the open sea from the berths. Due to the high mobility of marine mammals and the use of very extensive areas, it is necessary to consider the occurrence not only in the German EEZ, but in the entire area of the southern North Sea.

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

Marine mammals are among the TOP predators of marine food chains. They are therefore dependent on the lower components of the marine food chains: Firstly, on their direct food organisms (fish and zooplankton) and secondly, indirectly on phytoplankton. As consumers at the top of the marine food chains, marine mammals simultaneously influence the occurrence of food organisms.

2.8.1 Data situation

The occurrence of harbour porpoises in the North Sea and especially in German waters has been extensively studied over the last 25 years.

The large-scale surveys include the three so-called SCANS surveys (Small Cetacean Abundance in the North Sea and adjacent waters), which cover the entire area of the North Sea, Skagerrak, Kattegat, western Baltic Sea/Belt Sea, Celtic Sea and other parts of the north-eastern Atlantic.

German waters are currently one of the areas of the North Sea that have been systematically and very intensively surveyed for the occurrence of marine mammals since 2000. The bulk of the data is provided by the surveys carried out as part of environmental impact studies, preliminary investigations to determine the suitability of areas, and construction and operation monitoring for offshore wind farms. In addition, studies are regularly carried out for the monitoring of nature conservation areas on behalf of the BfN. Finally, data is also collected within the framework of research projects investigating specific issues.

The data situation can currently be described as very good for areas EN1 to EN13 in the German EEZ. The data are also systematically quality-assured and used for studies, so that the current state of knowledge on the occurrence of marine mammals in German waters can be classified as good.

The current findings relate to different spatial levels:

- entire North Sea and adjacent waters: Surveys conducted as part of SCANS I, II and III from 1994, 2005 and 2016,
- Research projects in the German EEZ and in the coastal sea (including MINOS, MINOSplus (2002 - 2006) and StUKplus (2008 - 2012)),
- Investigations into the fulfilment of the requirements of the UVPG within the framework of the BSH's approval and planning approval procedures, as well as the construction and operation monitoring of offshore wind farms since 2001 and ongoing,
- Monitoring of nature conservation areas on behalf of BfN since 2008 and ongoing.

For the area of the German EEZ, the most extensive data are collected in the context of environmental impact studies and in the context of construction and operation monitoring of offshore wind farms. Marine mammals are surveyed from aircraft. With the introduction of the StUK4, airborne surveys are carried out with the help of high-resolution digital photo and video technology.

In addition, acoustic data on habitat use by harbour porpoises has been continuously recorded since 2009 with the help of underwater measuring systems such as C-PODs. Since 2009, the operators of offshore wind farms have maintained a network of CPOD stations in the German EEZ. The station network provides the most comprehensive and valuable data to date on harbour porpoise habitat use in the areas of the German EEZ of the North Sea.

Information on the occurrence of marine mammals is also provided by observations made as part of the ship-based survey of resting birds and seabirds according to StUK.

Current findings are obtained from the monitoring of offshore projects in the priority areas EN1, N2 and EN3 (study cluster North of Borkum), in the priority area EN4 (study cluster North of Helgoland), and from individual projects in the priority areas EN5 and EN6 to EN8 and partly EN9. The results from the construction and operational monitoring of offshore wind farms thus provide extensive spatially and temporally highly resolved data on the occurrence of marine mammals.

The priority areas EN10 to EN13 lie on the periphery of the studies for offshore wind farms and the study of nature conservation areas. The data available for the reserved areas EN14 to EN19 consists exclusively of the results of research projects and individual surveys for the "Doggerbank" nature conservation area.

The large-scale distribution and abundance in the German EEZ is surveyed as part of the monitoring of Natura2000 sites on behalf of BfN (monitoring reports on behalf of BfN 2008, 2009, 2011, 2012, 2013, 2016).

2.8.2 Spatial distribution and temporal variability

The high mobility of marine mammals depending on specific conditions of the marine environment leads to a high spatial and temporal variability of their occurrence. Both the distribution and abundance of the animals vary over the seasons. In order to be able to draw conclusions about seasonal distribution patterns and the use of areas, as well as to recognise effects of seasonal and interannual variability, large-scale long-term studies are particularly necessary.

2.8.2.1 Porpoises

The harbour porpoise (*Phocoena phocoena*) is the most common and widespread cetacean species in the temperate waters of the North Atlantic and North Pacific, as well as in some secondary seas such as the North Sea (EVANS, 2020). The distribution of the harbour porpoise is restricted to continental shelf seas with water depths predominantly between 20 m and 200 m due to its hunting and diving behaviour (READ 1999, EVANS, 2020). The animals are extremely mobile and can cover large distances in a short time. With the help of satellite telemetry, it was determined that harbour porpoises can travel up to 58 km within one day. The marked animals behaved very individually during their migration. The individually selected staging points ranged from a few hours to a few days (READ & WESTGATE 1997).

In the North Sea, the harbour porpoise is the most widespread cetacean species. In general, the harbour porpoises occurring in German and neighbouring waters of the southern North Sea are assigned to a single population, the North Sea population including the Skagerrak, northern Kattegat and eastern part of the English Channel (ASCOBANS 2005, EVANS 2020).

The best overview of harbour porpoise abundance throughout the North Sea is provided by the large-scale surveys of small cetaceans in northern European waters conducted in 1994 and 2005 as part of the SCANS surveys (HAMMOND et al. 2002, HAMMOND & Macleod 2006, Hammond ET al. 2017). The large-scale SCANS surveys allow estimation of stock size and population trends across the entire area of the North Sea that is part of the habitat of highly mobile animals, without claiming to map marine mammals in detail 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, a larger area was covered in the SCANS II survey and consequently a larger number of 385,617 animals was estimated. However, the abundance calculated on an area of the same size as in 1994 was about 335,000 animals. The most recent survey in 2016 showed a mean abundance of 345,373 (minimum abundance 246,526, maximum abundance 495,752) animals in the North Sea. As part of the statistical evaluation of the data from SCANS-III, the data from SCANS I and II were recalculated. The results from SCANS I, II and III do not indicate a decreasing trend in harbour porpoise abundance 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 south-west than the north-west in 2005 (LIFE04NAT/GB/000245, Final Report, 2006) and high abundances were recorded across the English Channel in 2016. The results from the latest SCANS survey (SCANS III) can be summarised as follows: The calculated abundance of harbour porpoise in the North Sea in 2016 is 345,000 (CV = 0.18) animals, which is comparable to the abundance in 2005 of 355, and in 1994 of 289,000 (CV = 0.14) animals (Hammond et al. 2017).

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 data from 2005 to 2013 inclusive in 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 porpoise in the North Sea. Data from 2005 to 2013 inclusive from the UK, Belgium, the Netherlands, Germany and Denmark were considered together in the study. Data from large-scale and transboundary visual surveys, such as those collected in the SCANS-II and Dogger Bank projects, as well as extensive data from smaller-scale national surveys (monitoring, EIS) were validated and seasonal and habitat distribution patterns were predicted (Gilles et al. 2016). The results of the habitat modelling were verified and confirmed during the study using data from acoustic surveys. This study is one of the first to take into account dynamic hydrographic variables such as surface temperature, salinity and chlorophyll, as well as food availability, especially of sand eels. Food availability was thereby modelled by the distance of the animals to known sand eel habitats in the North Sea. The habitat modelling showed significantly high densities in the area west of the Dogger Bank, especially for spring and summer. 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 (Gilles et al. 2016).

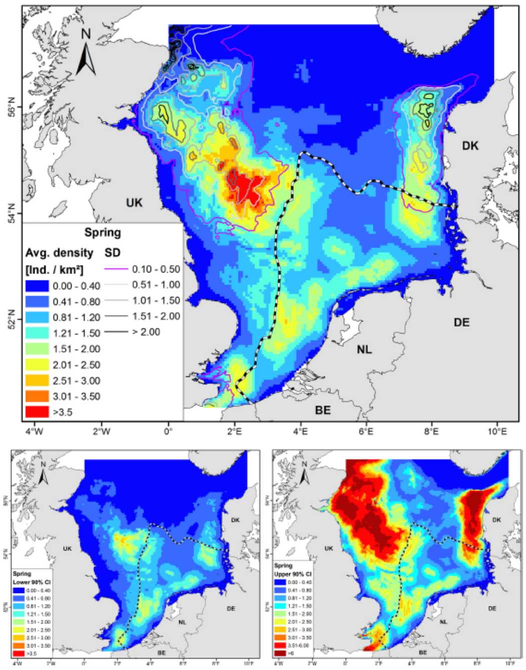


Fig. 35: Occurrence of harbour porpoise in the North Sea in spring (March to May inclusive): The figure above shows the averaged modelled density. The two figures below show the confidence intervals (Gilles et al., 2016).

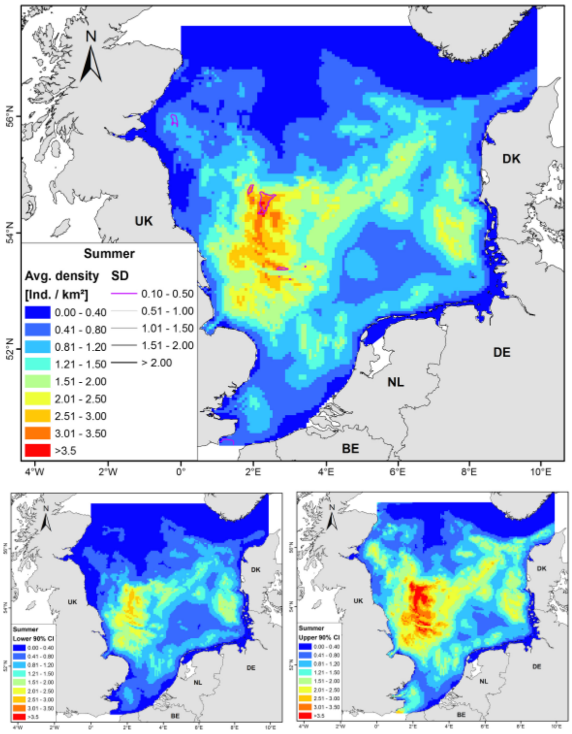


Fig. 36: Occurrence of harbour porpoise in the North Sea in the summer months (June to August inclusive): The figure above shows the averaged modelled density. The two figures below show the confidence intervals (Gilles et al., 2016).

The results of the habitat modelling are shown in Figures 35 and 36. The predicted mean density of harbour porpoise varies spatially as well as seasonally in the area under consideration (Gilles et al., 2016).

Occurrence of the harbour porpoise in the German North Sea

The German EEZ is part of the harbour porpoise habitat in the North Sea. The north-eastern part of the German EEZ is part of a larger contiguous area with high sighting rates of harbour porpoises (REID et al. 2003, GILLES et al., 2016). In comparison, the remaining areas of the German EEZ have lower sighting rates.

Especially in the summer months, the area of the coastal sea and the German EEZ off the North Frisian Islands, especially north of Amrum and near the Danish border, are intensively used by harbour porpoises (SIEBERT et al. 2006). In addition, the presence of mother-calf pairs is always confirmed there in the summer months (SONNTAG et al, 1999).

The large-scale surveys on the distribution and abundance of harbour porpoises and other marine mammals conducted in the framework of the MINOS and MINOSplus projects from 2002 to 2006 (SCHEIDAT et al. 2004, GILLES et al. 2006) provide an overview of the occurrence in 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 North Sea waters was estimated at 34,381 individuals in 2002 and 39,115 individuals in 2003. In addition to the pronounced temporal variability, a strong spatial variability was also found. The seasonal analysis of the data showed that temporarily, e.g. in May/June 2006, up to 51,551 individuals may have been present in the German EEZ of the North Sea (GILLES et al. 2006). Since 2008, the abundance of harbour porpoises has been determined as part of the monitoring of Natura2000 sites. Although abundance varies between years, it always remains at high levels, especially in the summer months and in spring. In May 2012, the highest abundance recorded to date in the German North Sea was 68,739 animals.

The survey of the harbour porpoise from 2013 onwards has confirmed fluctuations in the population in the EEZ with marked occurrence in the nature reserves. In particular, the occurrence in the area of the nature reserve "Borkum Riffgrund" was confirmed. The occurrence of the harbour porpoise in the German EEZ of the North Sea can be classified based on habitat modelling of data from 2006 to 2013 inclusive on the contiguous habitat of the harbour porpoise in the North Sea (Gilles et al., 2016).

The distribution of harbour porpoise in the German North Sea EEZ based on current data from 2012 to 2018 inclusive from the monitoring of nature reserves as well as from research projects also confirms known patterns with higher occurrence in the nature reserves as well as in the reserved area harbour porpoise and a rather low occurrence in the areas east/south-east of the nature reserve "Sylter Außenriff -Östliche Bucht" and north/north-west of the nature reserve "Borkum Riffgrund" (Fig. 37 from Gilles et al., 2019).

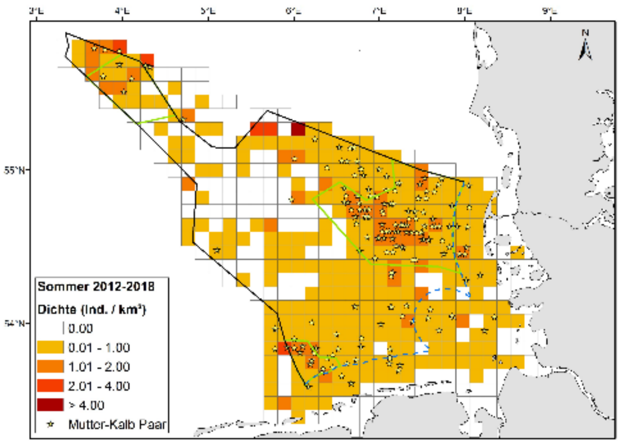


Fig. 37. Occurrence of harbour porpoise in the German EEZ of the North Sea based on data from nature reserve monitoring and research projects from 2012 to 2018 inclusive (Gilles et al., 2019).

Occurrence in nature reserves

Based on the results of the MINOS and EMSON 9surveys, three sites of special importance for harbour porpoises were defined in the German EEZ. These were notified to the EU as offshore protected areas under the Habitats Directive and recognised by the EU in November 2007 as Sites of Community Importance (SCI): Dogger Bank (DE 1003-301), Borkum Riffgrund (DE 2104-301) and in particular Sylt Outer Reef (DE 1209-301). Since 2017, the three FFH areas in the German EEZ of the North Sea have been given the status of nature conservation areas:

- Ordinance on the Establishment of the Nature Conservation Area "Borkum Riffgrund" (NSGBRgV), Federal Law Gazette I, I p. 3395 of 22.09.2017,
- Ordinance on the Establishment of the "Doggerbank" Nature Conservation Area (NSGDgbV), Federal Law Gazette I, I p. 3400 of 22.09.2017,
- Ordinance on the Establishment of the Nature Conservation Area "Sylt Outer Reef - Eastern German Bight" (NSGSylV), Federal Law Gazette I, I p. 3423 of 22.09.2017.

An up-to-date description of the occurrence of harbour porpoises in nature conservation areas, taking into account current findings, has been published by the BfN (BfN, 2017).

The nature reserve "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 reserve "Sylt Outer Reef - Eastern German Bight" has the function of a nursery area. In the period from 1 May to the end of August, mother-calf pairs are frequently recorded in the area of the protected area "Sylt Outer Reef - Eastern German Bight".

The nature reserve "Borkum Riffgrund" is of great importance for harbour porpoises in spring and partly in the first summer months. Significant densities are regularly recorded during this time.

The nature reserve "Doggerbank" has a lower occurrence compared to the other two nature reserves. In the Dogger Bank area, animals were mainly recorded in the summer months. Mother-calf pairs also occur. Their presence in the summer months also suggests a function as a breeding area.

Results from the monitoring of Natura2000 sites as well as from the monitoring of offshore wind farms have shown a high occurrence of harbour porpoise in the area of protected areas until 2013, especially in the area of the Sylt Outer Reef (GILLES ET AL., 2013, GILLES ET AL., 2019).

[9] Survey of marine mammals and seabirds in the German EEZ of the North Sea and Baltic Sea

However, current findings from the monitoring of Natura2000 sites show a change in the populations in the German EEZ, which also particularly affects the nature reserve "Sylter Außenriff - Östliche Deutsche Bucht" (GILLES ET AL. 2019, NACHTSHEIM ET AL., 2020).

Occurrence in the reserved area for harbour porpoises in the German EEZ

As part of the noise protection concept for the North Sea (BMU, 2013), a main concentration area of harbour porpoise was identified west of Sylt in the summer months of May to August inclusive, based on data from the period 2005 to 2010 inclusive. The main concentration area comprises the nature reserve "Sylt Outer Reef - Eastern German Bight" and adjacent areas to the west/northwest.

Figure 38 shows the main concentration area of harbour porpoise in the German EEZ identified in the BMU noise protection concept (2013).

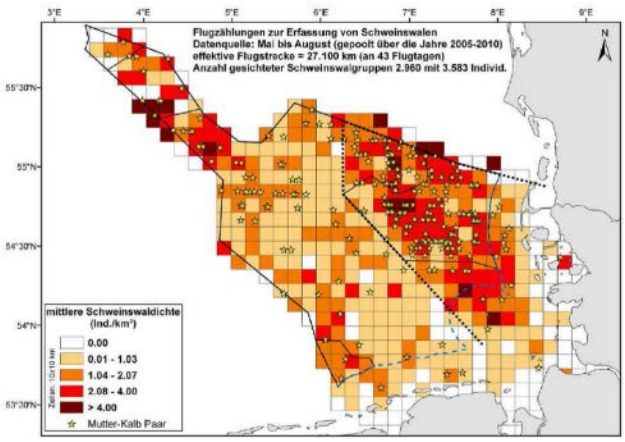


Figure 38. grid representation of the distribution of harbour porpoises in the German North Sea and sightings of mother-calf pairs (Gilles, unpubl., cited in BMU, 2013).

The main concentration area is defined as a reserved area for harbour porpoise because of its special importance for the conservation of the population. The special importance of the reserved area results from the regular occurrence of the harbour porpoise in the summer months and in particular from the occurrence of mother-calf pairs within this area. In the area of the reserve, the food-rich frontal system running west of the North Frisian coast expands in response to weather conditions, creating high quality habitats for marine predators. The distribution patterns of harbour porpoise and in particular mother-calf pairs within the reserve vary between years depending on hydrographic conditions and associated food availability. The variability of occurrence within the reserve may reflect the spatial and temporal extent of the frontal system, as illustrated in Section 3.2.5 (Fronts).

Occurrence in priority areas EN1, EN2 and EN3

Information on the occurrence of marine mammals in the priority areas EN1, EN2 and EN-3 for the period 2008 to 2012 is provided by the surveys carried out during the third year of investigation and the construction and operation monitoring for the "alpha ventus" project. For this purpose, extensive airborne surveys of marine mammals according to StUK were carried out in the entire area of the German EEZ between the traffic separation areas TGB and GBWA, in which the project area is also located. Parallel to the visual surveys, acoustic surveys of harbour porpoises were also carried out using underwater acoustic detectors (ROSE et al. 2014).

In the period 2009-2012, additional surveys of marine mammals were carried out as part of the accompanying ecological research (StUKplus project) for the "alpha ventus" test field. The study area of the airborne surveys covered a large area of the planning area. The focus of the ecological research here was also on recording the effects of the sound-intensive pile-driving work as well as on recording possible behavioural reactions of harbour porpoises with regard to the wind turbines in operation. The highest densities were always found to the west of areas EN2 and EN3 in the "Borkum Riffgrund" nature reserve. The highest density in 2010 was 2.58

individuals/km2 and was recorded in summer (GILLES et al. 2014).

Since 2013 and on an ongoing basis, large-scale so-called cluster investigations have been carried out in the area north of the East Frisian Islands in accordance with the BSH standard for investigating the impact of offshore wind turbines on the marine environment (StUK4). The entire area of sites EN1, EN2 and EN3 is part of the large study area of the cluster north of Borkum, where nine wind farms have been constructed since 2009 to 2018 and six of which are already in regular operation. Thus, current data on the occurrence of harbour porpoise as well as on possible impacts from construction and operation phases of the already realised wind farms in the entire area north of Borkum are available.

Findings from the construction and operation monitoring for the "alpha ventus" test site in the years 2010 to 2013 inclusive, from the accompanying research for the "alpha ventus" test site, and from the monitoring of the Natura2000 areas indicate intensive use of the surrounding area by harbour porpoises. The highest densities were always found to the west of the project area in the "Borkum Riffgrund" nature reserve. The highest density in 2010 was 2.58 individuals/km2 and was recorded in summer (GILLES ET AL., 2014, ROSE ET AL., 2014).

The results from the cluster surveys "North of Borkum" have shown a change in the occurrence of harbour porpoise since 2014 with a trend towards lower densities (Krumpel et al., 2017, Krumpel et al., 2018, Krumpel et al., 2019). The results from the cluster surveys north of the traffic separation areas, north of Helgoland and north of Amrumbank also indicate a trend towards lower densities of harbour porpoise in the majority of cases since 2013. The results of the cluster surveys "North of Borkum" thus fit into the overall picture of changes in the occurrence of harbour porpoise in the German EEZ of the North Sea and in the southern North Sea. Compared to the occurrence of the harbour porpoise in other areas of the German EEZ in the North Sea, however, the changes in the area north of Borkum are the smallest. The entire area north of Borkum with the nature reserve "Borkum Riffgrund" 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 recording of harbour porpoise in the cluster surveys "North of Borkum" also show a 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 investigations also confirm a higher abundance and use by harbour porpoises of the western part of the study area, especially the FFH area "Borkum Riffgrund". Harbour porpoise abundance and habitat use decreases eastwards in the area north of Borkum, with occasional high densities found in different parts of the area. Distribution patterns appear to be related to food availability (KRUMPEL ET AL., 2017, KRUMPEL ET AL., 2018, KRUMPEL ET AL., 2019, GILLES ET AL., 2019).

The SCANS III showed a further shift in the stock from the south-eastern area of the North Sea more towards the south-western area towards the English Channel in the 2016 large-scale survey (HAMMOND ET AL., 2017). A preliminary analysis of research data and data from national monitoring of nature reserves also suggests a shift in the stock, with the authors considering several factors as possible reasons for the observed change (GILLES ET AL., 2019). The results from visual and acoustic surveys also confirm, as before, higher abundance and use by harbour porpoises of the western part of the study area, in particular the FFH area "Borkum Riffgrund". Abundance and use seem to decrease in an easterly direction.

Occurrence in the reserved area EN4 and in the priority area EN13

The area of the reserved area EN4 is located in the study area C_South of the monitoring for the Natura2000 sites. The findings from the monitoring commissioned by the BfN confirm lower densities in the area of site EN4 compared to site C_North of the monitoring, where site N-5 is located. In contrast to the low occurrence of harbour porpoise in study area C_South, study area C_North with subarea I of the nature reserve "Sylt Outer Reef - Eastern German Bight" shows high seasonal densities in late spring and summer. In summer 2009, for example, a mean density of 0.58 individuals/km2 was recorded in the immediate vicinity of site N-4, while in sub-area I of the nature reserve "Sylter Außenriff - östliche Deutsche Bucht" the mean density was almost three times as high at 1.64 individuals/km2 (e.g. BfN Monitoring Report - Marine Mammals, 2009-2010). The differences in mean density and abundance were also confirmed during the surveys from 2012 onwards.

Especially in May 2012, the mean density in the area of site EN4 with only 0.50 ind./km2 was significantly lower than in the study area C-North or in subarea I of the protected area "Sylt Outer Reef - Eastern German Bight" with 2.89 ind./km2 (Monitoring report of the BfN - Marine Mammals, 2011-2012).

The investigations of the cluster "Nördlich Helgoland" for the three wind farms "Meerwind Süd/Ost", "NordseeOst" and "Amrumbank West", which are also located in area EN4, have shown that harbour porpoises use this area evenly and continuously, regardless of the construction and operation of the wind farms. While acoustic recording using CPODs shows a weak positive trend at some long-term stations, studies using digital recording show a rather lower occurrence in the wind farm areas than in areas outside the wind farms (IBL, BIOCONSULT-SH, IFAÖ, 2017, 2018).

Based on the new findings, areas EN4 and EN13 as well as a sub-area of area EN11 (close to the nature reserve) are of medium, and in summer even high, importance for harbour porpoises and are part of the identified main concentration area of harbour porpoise in the German North Sea (BMU, 2013).

Occurrence in the reserved area EN5

The sub-areas of the reserved area EN5 are regularly used by harbour porpoises for passage and residence as well as a feeding ground and breeding area. All surveys in the area of cluster 5 from research projects such as MINOS, MINOSplus and SCANS surveys, from EISs and the monitoring for offshore wind farm projects as well as from the monitoring of Natura2000 areas always confirm a high calf occurrence in the summer months. The waters west of Sylt are considered a nursery area for harbour porpoise due to the high proportion of sighted calves. Area N-5 is thus part of a large area used as a feeding and nursery ground for harbour porpoises.

Current findings from the monitoring of Natura2000 sites on behalf of the BfN also confirm high seasonal densities in late spring and summer in the area of the subplots of site EN5. Site EN5 is located in area C_North of the study area for the Natura2000 sites. In 2008, a mean density of 2.28 individuals/km² was recorded for study area C_North (BfN Monitoring Report - Marine Mammals, 2008-2009). In summer 2009, the density in area C_North was only 1.64 ind./km2 (BfN Monitoring Report - Marine Mammals, 2009-2010). In June 2010, a density of 2.12 individuals/km2 was recorded again (BfN Monitoring Report - Marine Mammals, 2010-2011).

These values were also confirmed by monitoring in the following years. The abundance for study area C_North was 23,163 animals in May 2012. This corresponds to a mean density of 2.89 individuals/km², which was significantly higher than in the adjacent study area C_South to the south

(BfN Monitoring Report - Marine Mammals, 2011-2012, 2014-2015).

Extensive information is also provided by the surveys carried out as part of the monitoring for the wind farm projects "DanTysk", "Sandbank" and "Butendiek": Over the entire monitoring period, harbour porpoises were sighted in the study area "DanTysk/Sandbank", -western area of the site EN5, with a total of 1,702 animals recorded in 2011, for example. The highest occurrence was observed mainly in summer. The mean density in the summer months was 3.8 individuals/km² and the proportion of calves varied between 10 and 25%. The highest calf percentages were recorded in June, July and August (BIOCONSULT SH 2012a).

In the "Butendiek" study area directly to the east, it was found that harbour porpoise abundance remained low from September to March and only increased from the end of April. High densities, on the other hand, were recorded in the summer months. The highest density of 5.9 individuals/km² was recorded in June. The calculated mean density in summer was 2.2 individuals/km² and was thus within the range of densities recorded during BfN monitoring (BIOCONSULT SH 2012b). The high variability of occurrence between the individual survey days in summer was striking in the context of the high-frequency surveys presented here for both survey areas of the "DanTysk" and "Butendiek" projects.

The data from the ongoing operational monitoring of the "Butendiek" wind farm fit well into the long-term data series from this area of the German Bight and show that in the last three to five years - including the construction of the "Butendiek" wind farm - interannual fluctuations in the abundance of harbour porpoises have occurred throughout the study area. However, a clear trend is not evident, following a slight decrease in harbour porpoise abundance between the first years of the baseline survey (2001-2003) and the 3rd FY of the baseline survey (2011). This observation is supported by literature data and indicates a longer-term summer stock shift of harbour porpoises between 2003 and 2013 from offshore areas of the eastern North Sea towards the west. However, as this decrease began well before the start of construction, the construction and operation of the wind farm is not related to it. The continuous data from acoustic monitoring using C-PODs show the highest detection rates in late spring and early summer; in contrast to the other survey methods, acoustic monitoring also showed high detection rates at some stations in autumn. Trend analyses of the duration C-POD stations in the study area confirm the results from flight and boat surveys in recent years and show a weak positive trend over the last five years. Overall, the data from all survey methods show that harbour porpoises are continuously present throughout the area and their occurrence follows a relatively stable phenological pattern over the years. On a small scale, however, the occurrence fluctuates quite strongly both spatially and temporally. Due to these fluctuations, the increased immigration into the area from April/May onwards, and the occurrence of calves with simultaneous high summer densities, this area of the EEZ can continue to be considered an important feeding and reproduction area (BIOCONSULT SH 2018).

Occurrence in the priority areas EN6, EN7, EN8, EN9, EN10, EN11 and EN12

Current information on the occurrence of harbour porpoises in the German EEZ of the priority areas EN6 to EN10, EN12 and partly EN11 is provided by the operational monitoring for the projects "BARD Offshore I", "Veja Mate", "Deutsche Bucht" as well as "EnBW HoheSee" and "Albatros". Higher densities occur mainly in spring and late summer, lower densities mainly in autumn and early winter. On an annual average, the absolute abundances in the study years 2008 to 2013 are between 0.34 individuals/km² and 0.98 individuals/km², slightly to significantly above the values determined in the years 2004-2006. Over the course of the year, densities of

0.5 harbour porpoises/km² can be expected on average in this area of the German EEZ, with daily values generally varying between 0 and 2 individuals/km² depending on the season. The results of the acoustic monitoring carried out since 2008 and until today confirm the occurrence. In addition, the results from acoustic monitoring indicate that harbour porpoise activity is also high in the winter months. The proportion of calves recorded in the years 2008-2013 still does not indicate a particular importance of the area for the reproduction of the species. While a relatively stable occurrence of harbour porpoise was recorded in the years from 2005 to 2012, the occurrence decreased in the following years. It was not until the end of 2016 that a steady increase in the occurrence of harbour porpoises in the central area of the German EEZ in the North Sea became apparent again (final report on the construction phase of the OWP "BARD Offshore 1", PGU 2014, cluster monitoring cluster 6, report phase I (01/15 - 03/16) for the OWPs "BARD Offshore I", "Veja Mate" and "Deutsche Bucht", PGU 2017, environmental monitoring in the cluster "Östlich Austerngrund" annual report 2016 - April 2015 - March 2016).

Occurrence in the reserved areas *EN14 to EN19*

The area of the reserved areas EN14 to EN18 includes the shipping route 10 and the southern area of the Duck's Bill. Reserved area EN19 covers the northern area of the Duck's Bill.

The entire area of the reserved areas EN14 to EN19 has not been studied as intensively as the already described areas EN1 to EN13 inclusive. There have only been individual surveys as part of the monitoring for the "Doggerbank" nature reserve, which also provide information on these areas (BfN, 2012, BfN 2014). As part of the monitoring of the Natura2000 areas, an exceptionally high occurrence of harbour porpoises was recorded in this area of the German EEZ in May 2012, which was even higher than in the area of the Natura2000 site "Sylter Außenriff" or Area I of the nature reserve "Sylter Außenriff - Östliche deutsche Bucht". However, the observations in 2012 remained exceptional due to comparatively lower densities in the summer months in the nature reserves as a whole. Surveys from 2009, 2013 and 2015, as part of research projects, among others, show that area EN19 tends to make up the periphery of the harbour porpoise's main distribution range from the western coast of the UK to the Dogger Bank (Gilles et al.2012, Geelhoed et al. 2014, Cucknell et al. 2017).
The occurrence of the harbour porpoise in the reserved areas EN14 to EN 19 can be estimated from habitat modelling using data from 2006 to 2013 inclusive and from the contiguous habitat of the harbour porpoise in the North Sea (Gilles et al., 2016).
The habitat modelling, taking into account all available data up to and including 2013, shows that areas EN14 up to and including EN18 belong to the areas of the North Sea with lower harbour porpoise abundance. Area EN19, on the other hand, is located at the edge of the large contiguous range of the harbour porpoise with high densities east of the British Isles, extending to the Dogger Bank.

The distribution of harbour porpoise in the German EEZ of the North Sea based on current data from 2012 to 2018 inclusive from the monitoring of nature reserves as well as from research projects also confirms a low occurrence in areas EN14 to EN18 inclusive and a comparatively higher occurrence in the nature reserve "Doggerbank" as well as in area EN19 (Gilles et al., 2019).

2.8.2.2 Seals and grey seals

The common seal is the most widespread seal species in the North Atlantic and is found along coastal regions throughout the North Sea. Regular flight counts are carried out throughout the Wadden Sea at the peak of the hair change in August. In 2005, 14,275 seals were counted in the entire Wadden Sea (Abtet al. 2005). Since some of the animals are always in the water and are not counted, this reflects the minimum population.

Suitable undisturbed resting places are of crucial importance for the occurrence of harbour seals. In the German North Sea, mainly sandbanks are used as resting places (Schwarz & Heidemann, 1994). Telemetric studies show that adult harbour seals in particular rarely move more than 50 km away from their traditional resting places (TOLLITet al. 1998). On foraging trips, the action radius is usually about 50 to 70 km from resting sites to hunting grounds (e.g.THOMPSON & MILLER 1990), although it can be as much as 100 km in the Wadden Sea area (OrthmannORTHMANN2000).

Censuses of grey seals at the time of the hair change have only been carried out occasionally in the German North Sea. In 2005, 303 animals were counted in Schleswig-Holstein during the hairstyle. For Lower Saxony, 100 animals are estimated (AK SEEHUNDE2005). These figures are only a snapshot.

Strong seasonal fluctuations are reported (ABTet al. 2002,ABT2004). The numbers observed in German waters must be seen in a broader geographical context, as grey seals sometimes undertake very long migrations between different resting sites throughout the North Sea region (MCCONNELLet al.(MCCONNELL 1999). The grey seals observed on resting sites in the coastal sea probably have their feeding grounds partly in the EEZ.

The compilation of the BfN's data basis confirms the already known picture of the occurrence of harbour seals and grey seals along the German coast in the North Sea (BfN, 2020a).

2.8.3 Status assessment of marine mammals as an object of conservation

In the German waters of the North Sea, the harbour porpoise is the key species used in the BMU's noise protection concept (2013) for assessing the potential impacts of impulsive noise. In addition, the harbour porpoise represents the indicator species for the assessment of cumulative impacts of uses and ultimately for the assessment of Good Environmental Status in the OSPAR area within the framework of the implementation of the MSFD.

The harbour porpoise population in the North Sea has declined over the last centuries. The situation of the harbour porpoise has already generally deteriorated in earlier times. In the North Sea, the stock has declined mainly due to bycatch, pollution, noise, overfishing and food limitation (ASCOBANS 2005). However, there is a lack of concrete data to calculate a trend or to forecast the trend development. The best overview of the distribution of harbour porpoises in the North Sea is provided by the compilation from the "Atlas of the Cetacean Distribution in North-West European Waters" (REID et al. 2003). However, when calculating abundance or population size on the basis of aerial surveys or even field trips, the authors point out that the occasional sighting of a large aggregation (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 recognition of distribution patterns or the calculation of populations is made particularly difficult by the high mobility of the animals.

The population of harbour porpoises throughout the North Sea has not changed significantly since 1994, or no significant differences were found between data from SCANS I, II and III (HAMMOND & MACLEOD 2006, Hammond ET al. 2017, Evans, 2020).

Statistical analysis of data from large-scale surveys conducted as part of research projects and, since 2008, as part of the monitoring of Natura2000 sites on behalf of BfN, indicates a clearly significant increase in harbour porpoise densities from 2002 to 2012 in the southern German North Sea. In the area of the Sylt Outer Reef, the trend analysis also indicates stable populations in summer over the years 2002 to

2012 (Gilles et al. 2013). Especially the western area shows a positive trend for spring and summer, while no clear trend is detectable in autumn. Harbour porpoise densities in the eastern area have remained mostly constant over the years and significant differences between the hotspots in the west and lower densities in the south-eastern German Bight could be detected.

Current findings from the large-scale cluster surveys of offshore wind farms give no indication of decreasing trends in harbour porpoise abundance or changes in seasonal distribution patterns from 2001 to the present in the German North Sea EEZ. The multi-year data from the CPOD station network confirm continuous habitat use by harbour porpoises.

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

However, a current assessment of the stock trend in the German waters of the North Sea based on data from the monitoring of nature conservation areas and from research projects from 2012 to 2018 has shown a stock shift. Decreasing trends were observed in the area of the nature reserves "Sylt Outer Reef - Eastern German Bight" and "Dogger Bank" as well as in the central area of the German Bight. In contrast, a positive trend has been observed in the area of the nature reserve "Borkum Riffgrund" and in the areas EN1, EN2 and EN3. causes of the stock shift are not yet known and could be related to the impact of human activities but also to shifts in fish stocks (Gilles et al., 2019, Nachtsheim et al., 2020).

2.8.3.1 Importance of the priority and reserved areas for wind energy for marine mammals

According to current knowledge, it can be assumed that the German EEZ is used by harbour porpoises for transiting, staying and also as a feeding area and, depending on the area, as a nursery area. Based on the available knowledge, the EEZ is of medium to high importance for harbour porpoises in some areas. Habitat use varies in different areas of the EEZ. Marine mammals and, of course, harbour porpoises are highly mobile species that use large areas variably in search of food, depending on the hydrographic conditions and the food supply. It therefore makes little sense to consider the importance of individual areas, such as the areas covered by the plan or individual wind farm areas. In the following, the importance of areas that belong to a natural unit and that were additionally covered by intensive project-related surveys is estimated separately.

Priority areas EN1, EN2 and EN3

According to current knowledge, the priority areas EN1 to EN3 are of medium to - seasonally in spring - high importance for harbour porpoises. The investigations carried out as part of the monitoring of the Natura2000 sites as well as the monitoring for the offshore wind farm projects always confirm a significantly higher occurrence in the "Borkum Riffgrund" protected area with decreasing densities in an easterly direction.

- The areas are used year-round by harbour porpoises for passage, residence and probably as a feeding ground.
- The use of the areas by harbour porpoises is significantly higher in spring.
- The use of the areas by harbour porpoises in summer is rather average compared to the use of the waters west of Sylt.
- Sightings of calves in the areas are rather sporadic and irregular and therefore highly likely to rule out use as a rearing area.
- There is no evidence of any ongoing special function of areas EN1, EN2 and EN3 for harbour porpoises.

For grey seals and harbour seals, these three priority areas are of low to partly medium importance in the southern area.

Reserved area EN4 and priority area EN13

According to current knowledge, areas EN4 and EN13 and even the eastern part of area EN11 (close to the nature reserve) are of medium, and in summer even high, importance for harbour porpoises and are part of the identified main concentration area of harbour porpoises in the German North Sea (BMU 2013):

- The areas are used year-round by harbour porpoises for passage, residence and probably as a feeding ground.
- The occurrence of harbour porpoises in the vicinity of areas EN4 and EN13 is relatively high, but lower compared to the high occurrence in the waters to the west of Sylt (area EN5).
- Regular sightings of calves in these areas, albeit in comparatively small numbers, lead to the assumption that these areas should be seen as fringes of the large nursery area in the German EEZ of the North Sea.
- Due to their function as feeding and occasionally nursery areas, areas EN4 and EN13 are of medium to seasonal high importance for harbour porpoises.

Site EN4 is located at the western edge of the distribution range of seals and harbour seals from the Schleswig-Holstein Wadden Sea and is therefore of medium importance for both species.

Area EN13 has at most low importance for seals and harbour seals.

Reserved area EN5

Area EN5 is regularly used by harbour porpoises for passage and residence, as well as a feeding ground and nursery area.

According to current knowledge, the environment in which site EN5 is located is of high importance for harbour porpoises and represents the core area of the identified main concentration area of harbour porpoise in the German North Sea (BMU 2013):

- The area is used year-round by harbour porpoises for passage, residence and as a feeding ground.
- The use of area EN5 by harbour porpoises is intensive, especially in summer.
- Area EN5 is used by harbour porpoises as a nursery area during the summer months.
- The density of harbour porpoises in this area is high compared to other areas of the EEZ.
- Area EN5 is of high importance for harbour porpoises, especially as a feeding and nursery ground.

Site EN5 is located at the western edge of the distribution range of seals and harbour seals from the Schleswig-Holstein Wadden Sea and is therefore of rather medium importance for both species.

Priority areas EN6 to EN12

The priority areas EN6, EN7, EN8, EN9, EN10, EN11 and EN12 are regularly used by harbour porpoises for passage and stay or - depending on the seasonal food supply - as feeding grounds.

Due to the few sightings of mother-calf pairs, use as a nursery area can almost certainly be ruled out. According to current knowledge, these areas can be classified as of medium importance for harbour porpoises:

- The areas are used year-round by harbour porpoises for passage, residence and probably as a feeding ground.
- The use of the areas by harbour porpoises is significantly higher in spring and summer.
- The occurrence of harbour porpoises in these areas is average compared to the high occurrence in the waters west of Sylt.
- The irregular sighting of single mother-calf pairs rules out the use of these areas as a breeding ground with a high degree of probability.
- There is no evidence of any ongoing special function of the areas for harbour porpoises.

For the two seal species, the priority areas are of no particular importance due to the distance to the nearest resting and littering sites.

Reserved areas EN14 to EN19

The data situation for the reserved areas EN14 to EN19 is not sufficient to assess the occurrence of the harbour porpoise and the importance of the areas. Systematic studies to record seasonal patterns, inter-annual variability and abundance are lacking. Based on the available data, it can be assumed that the seasonal - in summer - importance of reserved area EN19 is medium.

- The reserved areas EN14 to EN18 are used by harbour porpoises throughout the year for passage, residence and probably as feeding grounds.
- The occurrence of harbour porpoises in these areas is average compared to the high occurrence in the waters west of Sylt.
- The occurrence of harbour porpoises in the vicinity of reservation area EN19 is higher in the summer months.
- In the reserved area EN19, mother-calf pairs occur in the summer months.

For the two seal species, the reserved areas are of no particular importance due to the distance to the nearest resting and littering sites.

2.8.3.2 Protection status

In the North Sea, the harbour porpoise is the most widespread cetacean species. In general, harbour porpoises occurring in German and neighbouring waters of the southern North Sea are assigned to a single population (ASCOBANS 2005, FONTAINE ET AL., 2007, 2010).

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 to protect 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 general strict species protection according to Art. 12 and 16 of the Habitats Directive.

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

In addition, mention should be made of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention), in Annex II of which the harbour porpoise is listed.

In Germany, the harbour porpoise is listed in the Red List of Threatened Animals (Meinig et al., 2020). Here it is classified in endangerment category 2 (critically endangered). The authors point out that the endangerment classification for Germany results from the joint consideration of threats in the North Sea and Baltic Sea. The occurrence in the North Sea is recorded by ship- and aircraft-based surveys and is described as stable. In the Borkum-Riffgrund nature reserve, there is a slight increase in abundance (Peschko et al. 2016, cited in Meining et al., 2020). However, due to ongoing threats from bycatch in gillnets, environmental toxins and noise, the authors have concluded to classify the status as "Endangered" despite the overall stable short-term population trend (Meinig et al., 2020). Studies in the Danish Baltic Sea and adjacent areas also indicate stable population sizes around 30,000 individuals (Sveegaard et al. 2013, Viquerat et al. 2014 cited in Meinig et al., 2020). In contrast, the results from the EU research project SAMBAH have shown that the population of the separate population of harbour porpoise in the central Baltic Sea is only around 500 animals (SAMBAH 2016). For this reason, this subpopulation is classified as "threatened with extinction".

Grey seal and harbour seal are also listed in Annex II of the Habitats Directive.

In the current Red List of Mammals of Germany, the grey seal is classified from endangerment category 2 (severely endangered) to category 3 (endangered) (Meinig et al., 2020).

The common seal is classified in category G (threats of unknown magnitude). The authors confirm that there are two separate populations in the German North Sea and Baltic Sea. The German North Sea population has seen an increase in juveniles since 2013 and after the two distemper virus epidemics, and would be classified as "not endangered" on its own, unlike the German Baltic Sea population (Meinig et al., 2020).

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

- Ordinance on the Establishment of the Nature Conservation Area "Borkum Riffgrund" (NSGBRgV), Federal Law Gazette I, I p. 3395 of 22.09.2017,
- Ordinance on the Establishment of the "Doggerbank" Nature Conservation Area (NSGDgbV), Federal Law Gazette I, I p. 3400 of 22.09.2017,
- Ordinance on the Establishment of the Nature Conservation Area "Sylt Outer Reef - Eastern German Bight" (NSGSylV), Federal Law Gazette I, I p. 3423 of 22.09.2017.

The conservation purposes of the nature conservation areas in the German EEZ of the North Sea include maintaining and restoring a favourable conservation status of the species from Annex II of the Habitats Directive, in particular the harbour porpoise, grey seal and harbour seal, as well as the conservation of their habitats (NSGBRgV, 2017. Bundesgesetzblatt, Teil I, Nr. 63, 3395).

The conservation purposes of the nature conservation areas in the German EEZ of the North Sea include the maintenance and restoration of a favourable conservation status of the species from Annex II of the Habitats Directive, in particular the harbour porpoise, grey seal and harbour seal, as well as the conservation of their habitats (NSGBRgV, 2017. Bundesgesetzblatt I, I p. 3395, NSGDgbV), Bundesgesetzblatt I, I p. 3400 of 22.09.2017, NSGSylV), Bundesgesetzblatt I, I p. 3423 of 22.09.2017).

2.8.3.3 Preloads

A variety of anthropogenic activities, changes in the marine ecosystem, diseases as well as climate change pose a threat to the population of harbour porpoises in the North Sea.

Pre-existing pressures on marine mammals result from fisheries, dolphin-like attacks, physiological effects on reproduction, diseases that may be associated with high levels of contaminants, and underwater noise. The greatest threats to harbour porpoise stocks in the North Sea come from fisheries, through bycatch in set and bottom trawls, depletion of prey fish stocks due to overfishing and associated reduction in food availability (Evans, 2020). An analysis of mortalities and strandings from 1991 to 2010 from the British Isles identified the causes as follows: 23% infectious diseases, 19% attacks by dolphins, 17% bycatch, 15% starvation and 4% stranded alive (Evans, 2020).

Current anthropogenic uses in the vicinity of areas with sound impacts include shipping traffic, seismic exploration, and military use or blasting of non-transportable munitions. Hazards to marine mammals can be caused during the construction of wind turbines and converter platforms with deep foundations, in particular by noise emissions during the installation of the foundations by pile driving, if no mitigation or avoidance measures are taken.

In addition to pressures from discharges of organic and inorganic pollutants or oil spills, threats to the stock also come from disease (bacterial or viral) and climate change (especially impact on the marine food chain).

2.9 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 "birds that stay in an area outside the breeding territory, usually for a longer period of time, e.g. for moulting, feeding, resting, wintering". Foraging guests are defined as birds "that regularly forage in the surveyed area, do not breed there, but breed or could breed in the wider region" (DEUTSCHE ORNITHOLOGEN-GESELLSCHAFT 1995).

Seabirds are bird species whose way of life is predominantly bound to the sea and which only come ashore for a short time to breed. These include, for example, fulmars, gannets and alcids (guillemots, razorbills). Terns and gulls, on the other hand, usually have a distribution closer to the coast than seabirds.

2.9.1 Data situation

In order to draw conclusions about seasonal distribution patterns and the use of different marine areas (sub-areas), a good data basis is necessary. In particular, large-scale long-term studies as well as extensive evaluations of existing data are required in order to be able to identify correlations in the distribution patterns as well as effects of intra- and interannual variability.

The findings on the spatial and temporal variability of the occurrence of seabirds in the southern North Sea are based on surveys by ESAS (European Seabirds at Sea) as well as on several spatially and temporally limited research projects (e.g. MINOS, MINOSplus, EMSON, StUKplus, HELBIRD, DIVER, TOPMarine). In recent years, the data base has expanded considerably due to a large number of new research programmes for monitoring Natura2000 areas, in the context of environmental impact studies, monitoring of offshore wind farm projects during construction and operation, but also research projects and studies focussing on scientific evaluations of existing data in the German EEZ of the North Sea. The available data basis can therefore be considered very good for the majority of the EEZ. Only for the area of the so-called "duck's bill" far from the coast is there no comprehensive data available, which is why the comments on this area do not go into detail.

2.9.2 Spatial distribution and temporal variability

Seabirds are highly mobile and thus able to search large areas for food or to pursue species-specific prey organisms such as fish over long distances. The high mobility - depending on special conditions of the marine environment - leads to a high spatial and temporal variability of the occurrence of seabirds. The distribution and abundance of birds vary over the seasons.

The distribution of seabirds in the German Bight is determined in particular by the distance to the coast or breeding areas, hydrographic conditions, water depth, the nature of the bottom and the food supply. Furthermore, the occurrence of seabirds is influenced by strong natural events (e.g. storms) as well as anthropogenic factors such as nutrient and pollutant inputs, shipping and fishing. As consumers at the top end of the food chain, seabirds feed on species-specific fish, macrozooplankton and benthic organisms. They are thus directly dependent on the occurrence and quality of benthos, zooplankton and fish.

Some areas of the German coastal sea and parts of the North Sea EEZ are of great importance for seabirds and waterbirds, not only nationally but also internationally, as a number of studies have shown, 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 reserve "Sylt Outer Reef - Eastern German Bight", which was designated as a Special Protected Area (SPA) in accordance with the V-Directive (79/409/EEC) by decree of 22 September 2017.

With regard to the diver species group, a main concentration area was identified in the German Bight in spring as part of an overarching evaluation and assessment of existing data sets (BMU 2009).

2.9.2.1 Abundance of seabirds and resting birds in the German North Sea

In the EEZ of the German North Sea, there are 19 seabird species that are regularly recorded as resting birds in larger populations. The following Table 12contains population estimates for the most important seabird species in the EEZ and the entire German North Sea in the seasons with the highest occurrence.

Table 11: Populations of the most important resting bird species in the German North Sea and EEZ in the most abundant 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).

German name (*scientific Name*)	Season	Stock dt. North Sea	Stock dt. AWZ
Red-throated diver (*Gavia stella*)	Winter	3.600	1.900
	Spring	22.000	16.500
Black-throated diver (*Gavia arctica*)	Winter	300	170
	Spring	1.600	1.200
Gannets (*Morus bassanus*)	Summer	1.400	1.200
Great black-backed gull (*Larus marinus*)	Winter	15.500	9.000
	Autumn	16.500	9.500
Herring 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
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
Tordalk (*Alca torda*)	Winter	7.500	4.500
	Spring	850	800
Guillemot (*Uria aalge*)	Winter	33.000	27.000
	Spring	18.500	15.500

2.9.2.2 Frequently occurring species and species of special importance for the nature reserve "Sylt Outer Reef - Eastern German Bight

The occurrence of seabirds shows a very high spatial and temporal variability. Long-term observations and systematic counts provide information on recurring seasonal distribution patterns of the most common species in German waters of the North Sea. In the following, the most common and specially protected species are considered individually due to species-specific differences in spatial and temporal distribution.

Red-throated diver (*Gavia stellata*) and black-throated diver (*Gavia arctica*)

The two species cannot always be reliably distinguished from each other in aircraft- and ship-based counts. For this reason, both species are presented together in this case. The share of the black-throated diver amounts to approx. 8 to 11% according to all previous findings.

Divers are regularly distributed along the coast of the south-eastern North Sea in winter. Towards spring, the centre of occurrence shifts further north, especially in the area west of Sylt. At this time of year, the distribution extends almost 100 km into the EEZ (MENDEL et al. 2008). Based on many years of data collection in the German EEZ, a main distribution area (main concentration area) of divers in spring was identified and defined off the North Frisian Islands (BMU 2009). An evaluation of data from research projects, environmental impact studies and monitoring of offshore wind farm projects from the years 2000 to 2013 before the construction of the wind farms showed that the seasonal distribution foci of the common diver in the German Bight had remained spatially largely constant over a longer period of time. At the same time, there was a clear expansion of the diver occurrence in a westerly direction, confirming the importance of the main concentration area (GARTHE et al. 2015). A study by the FTZ on behalf of the BSH and the BfN, which, in addition to the data basis of the 2015 study, takes into account data from the construction and operational phases of the offshore wind farm projects in 2014-2017, shows a shift of the diver occurrence after construction of the wind farms to the central area of the main concentration area, which is furthest away from the realised projects (GARTHE et al. 2018, GARTHE et al. 2019, Figure 46). A recent study commissioned by the Bundesverband der Windparkbetreiber Offshore e.V. (BWO) confirms this observation (BIOCONSULT SH et al. 2020).

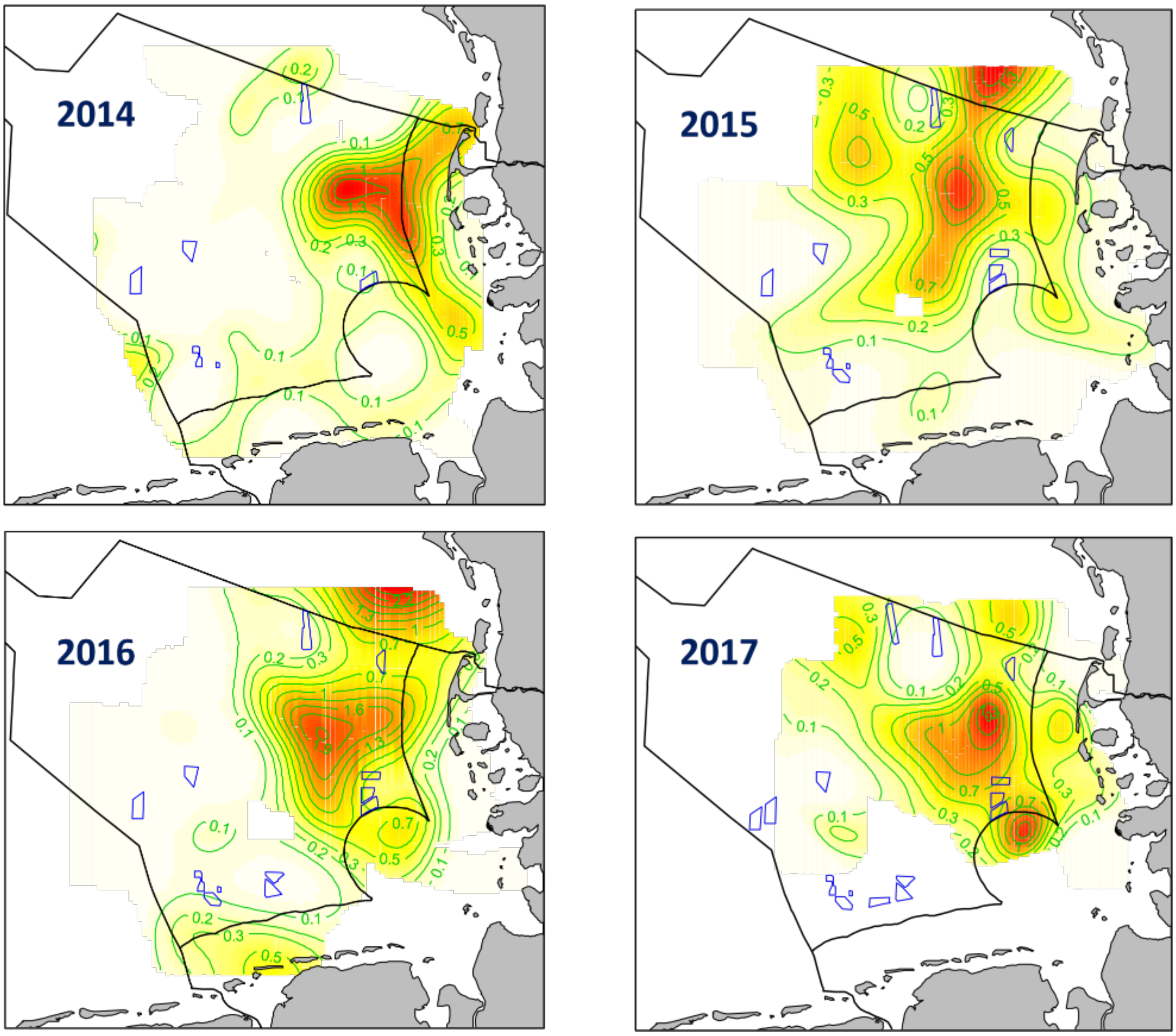


Figure 36: Interpolated diver densities in the German Bight in spring 2014 - 2017. Offshore wind farm projects in operation at the time of data collection are outlined in blue. Numbers indicate interpolated densities (GARTHE et al. 2019).

Little Gull (*Larus minutus*)

The German Bight, where Lesser Black-backed Gulls reach only low population densities, is located at the north-eastern edge of the winter distribution of European Lesser Black-backed Gulls (GLUTZ von BLOTZHEIM & BAUER 1982). In general, a considerable part of the north-western European population flies over the coastal areas of the German North Sea coast during migration home and away, as many years of observations from research projects and EIAs have consistently shown. High densities can then be observed especially in the area of the Elbe estuary (MARKONES et al. 2015). During the breeding season and in summer, only isolated individuals are present in the German EEZ (MENDEL et al.

2008). The high occurrence during migration is followed by a lower, constant winter occurrence in the German North Sea, which is mainly restricted to the coastal sea, the nature reserve "Sylter Außenriff - Östliche Deutsche Bucht" and the nature reserve "Borkum Riffgrund". In general, their occurrence depends strongly on the prevailing weather.

Sandwich Tern (*Thalasseus sandvicensis*)

The range of the Sandwich Tern in the pre-breeding season, during the breeding season and during migration runs along the coast of the North Sea - with most birds in a 20 to 30 km wide strip and concentrations near known breeding colonies on Norderoog, Trischen and Wangerooge.

The FTZ's long-term data series show that the main occurrence of Sandwich Terns in the German North Sea is in the summer half-year. Sandwich Terns then occur over a wide area in the entire territorial sea. In the area outside the territorial sea, Sandwich Terns occur only sporadically (MENDEL et al. 2008). In areas with a water depth of more than 20 m, there are hardly any foraging Sandwich Terns.

Common Tern (*Sterna hirundo*) and Arctic Tern (*S. paradisaea*)

Common and Arctic Terns cannot always be reliably distinguished from each other under unfavourable observation conditions and are therefore treated together. During the breeding season, both Common and Arctic Terns stay in a strip off the coast, which only extends somewhat into the EEZ in the northern part. Highest densities are found near the breeding sites on the offshore islands. The distribution of the two tern species after the breeding season is clearly similar to that during the breeding season. However, local foci are less clearly located near the breeding sites, which are no longer occupied at this time. The EEZ gains some importance after the breeding season, especially the area off the North Frisian Islands (MENDEL et al. 2008).

Common Guillemot (*Uria aalge*)

Common guillemots are typical seabirds that only stay on land during the breeding season. The only breeding colony in German waters is located on Helgoland and is currently estimated at about 2,811 breeding pairs (BMU 2020). During the breeding season, the birds only leave the colony to forage within a maximum radius of 30 km. During the breeding season, the occurrence of the Common Guillemot is therefore concentrated in the German Bight and in the vicinity of the breeding colony on Helgoland. Further northwest, Common Guillemots occur only in low densities at this time of year (MENDEL et al. 2008).

From late summer and autumn, the occurrence of the Common Guillemot shifts to offshore areas with water depths between 40-50 m up to the so-called "duckbill" of the German EEZ (MARKONES & GARTHE 2011, Borkenhagen ET al. 2018) (see Figure 47During this period, adults are often observed with their young, which, however, most likely originate from British breeding colonies.

In winter, Common Guillemots reach the highest densities and occur almost everywhere in the German EEZ of the North Sea (MENDEL et al. 2008). According to current knowledge, the areas of the EEZ between and north of the traffic separation areas off the East Frisian coast are intensively used by guillemots in autumn and winter. In spring, Common Guillemots gradually retreat towards the breeding colony.

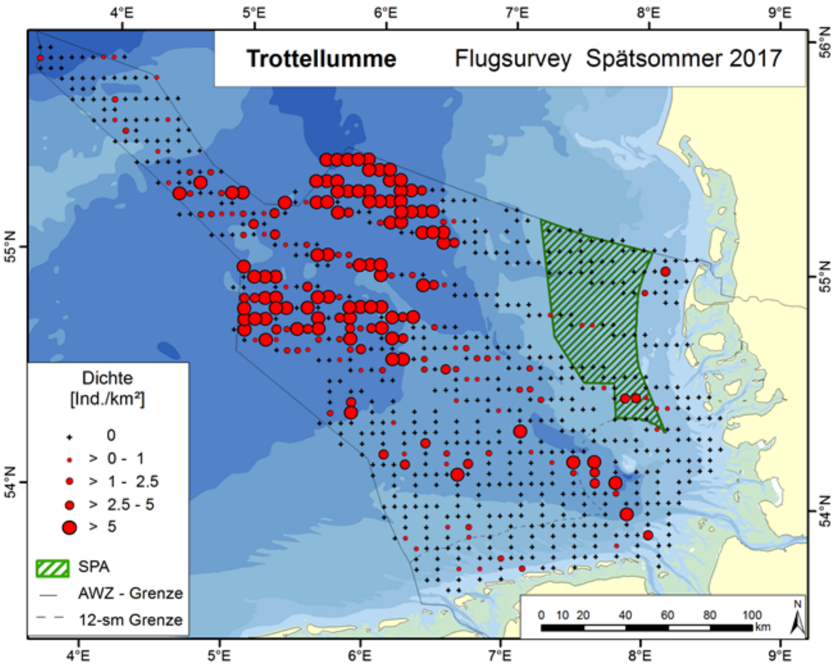


Figure 37: Distribution of Common Guillemots in the German Bight in late summer 2017, based on four aerial surveys in the period 11.08. - 30.08. 2017, and one survey on 03.09.2017 (BORKENHAGEN et al. 2018).

Razorbill (*Alca torda*)

Razorbills are relatively evenly distributed in the coastal waters of the EEZ in winter. A clear concentration occurs off the East Frisian Islands. At other times of the year, the occurrence in German waters remains low (MENDEL et al. 2008). The FTZ's long-term data series confirm the razorbill's main occurrence in the winter months. The highest concentrations occur north of Borkum and Norderney and extend into areas far from the coast (MENDEL et al. 2008).

Gannet (*Sula bassana*)

Gannets occur in low densities in large parts of the German North Sea, without any particular concentrations being evident. This is confirmed by more recent studies (MARKONES et al. 2014, MARKONES et al. 2015). Despite the currently observed increase, Helgoland's breeding colony is too weak in individuals to be clearly noticeable at sea. The FTZ's long-term data series indicate a year-round, albeit low occurrence of the gannet in the entire German Bight (MENDEL et al. 2008).

fulmar (*Fulmarus glacialis*)

Northern fulmars occur in the German North Sea all year round and almost everywhere. In areas far from the coast, they occur in higher densities than in areas close to the coast (MARKONES et al. 2015, BORKENHAGEN et al. 2018). Long-term data from the FTZ indicate a year-round occurrence in the German Bight. However, the highest numbers are encountered in summer in areas with saline and temperature-stressed North Sea water (MENDEL et al. 2008). During baseline surveys for offshore wind farm projects, fulmars were also found to occur in higher densities beyond the 40 m depth line. The breeding colony on Helgoland is still too small to have a significant impact on populations at sea. Northern fulmars are regularly found in high densities at a distance of more than 70 km from the coast, especially in summer.

Great black-backed gull (*Larus marinus*)

Great black-backed gulls are present in the German North Sea all year round. In spring and summer, they occur in low densities both near and far from the coast at a distance of 80 km from the coast. In autumn, the occurrence increases steadily and leads to a large winter occurrence in the Elbe estuary and along the East Frisian coast. In the area far from the coast, only isolated black-backed gulls occur (MENDEL et al. 2008). A recent trend analysis based on comprehensive ship transect surveys from 1990 to 2013 revealed a significant negative population development of the Great Black-backed Gull in the North Sea. The reason for this is not a decline in the breeding population, but an increasing shift in resting occurrences and a decreasing importance of marine food sources (MARKONES et al. 2015).

Herring Gull (*Larus fuscus*)

During home migration and the pre-breeding season, the main distribution of Herring Gulls is about 60 km off the coast. Both during and after the breeding season, the herring gull is a widespread species in the German Bight. Focal points are the coastal sea off Schleswig-Holstein and Lower Saxony and the adjacent areas of the EEZ, especially west of the island of Helgoland. The herring gull is a known ship-follower. Their sometimes highly concentrated occurrence is therefore often observed in connection with fishing activity. In the area around the island of Helgoland, the herring gull is the only seabird species to occur in high densities in the summer half-year and is the most common seabird species in the German North Sea during this period. Recent studies show a decrease in the summer occurrence of the herring gull in the German North Sea, as is also the case for the great black-backed gull. However, this is not due to a decline in the breeding population, but rather to a shift in occurrence to terrestrial areas (MARKONES et al. 2015).

Black-legged Kittiwake (*Rissa tridactyla*)

Kittiwakes, along with herring gulls and guillemots, are among the most common species in the German North Sea EEZ and occur all year round. The FTZ's long-term data series indicate a clearly concentrated occurrence around Helgoland in spring and summer and also in a north-westerly direction along the Elbe glacial valley and in the area of the Duck's Bill in summer (BORKENHAGEN et al. 2017, BORKENHAGEN et al. 2019).

In autumn, the occurrence expands further into the offshore areas. In winter, the occurrence increases in areas close to the coast, but local aggregations with large numbers of individuals also occur scattered in areas far from the coast (MENDEL et al. 2008). This is also shown by recent studies within the framework of seabird monitoring on behalf of the BfN (MARKONES et al. 2014).

Common Gull (*Larus canus*)

Gulls are widespread near the coast in the eastern and southern parts of the German Bight in winter. The highest densities are reached in the Elbe-Weser estuary, in the area of the Ems estuary and off the North Frisian Islands. The FTZ's long-term data series show that Common Gulls are present in the German North Sea all year round, but the largest numbers in the area far from the coast are reached in winter. The winter occurrence extends with high densities over the entire nearshore area down to the 20 m depth contour. In areas far from the coast, gulls still occur regularly, but in significantly lower numbers (MENDEL et al. 2008). In the other seasons, storm-petrels stay closer to the coasts, where their breeding sites are also located (see Figure 48). The occurrence of storm-petrels is also strongly weather-dependent.

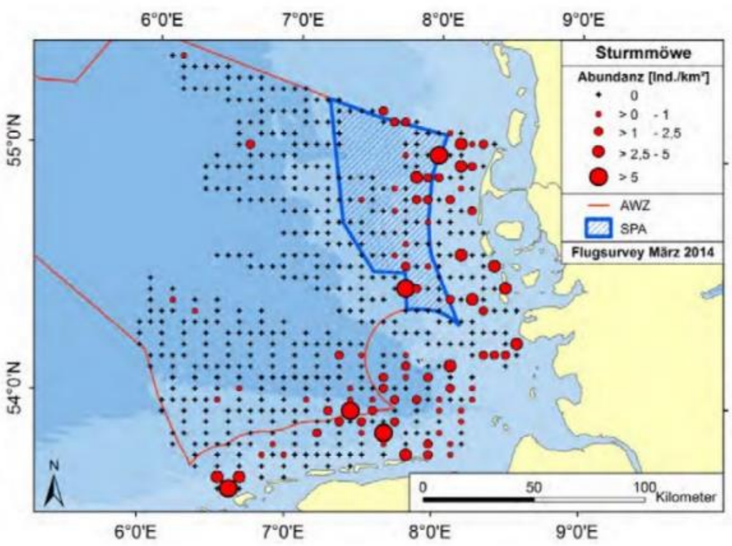


Figure 38: Occurrence of Common Gulls in the German North Sea - aerial surveys 04, 12 & 13.03.2014 (Markones ET al. 2015).

Skua (*Stercorarius skua*)

Skuas are very rarely observed in the German Bight (BORKENHAGEN et al. 2018). Occasional occurrence is possible throughout the year, but a focus is mainly seen during migration from the end of June to November. In the eastern part of the German Bight, the occurrence is often observed in connection with strong westerly winds (DIERSCHKE et al. 2011).

Pomarine Skua (*Stercorarius pomarinus*)

Spatula skuas mainly occur during autumn migration in the German North Sea. The occurrence is subject to strong annual fluctuations and is therefore extremely variable (PFEIFER 2003).

Common Scoter (*Melanitta nigra*)

Common scoter are present in the German North Sea all year round, but their occurrence is concentrated in offshore areas close to the coast and shallower. In spring and autumn, the occurrence of scoters is determined by migration. In winter, the coastal areas serve as important resting habitats, and in summer a moulting migration can be observed. The offshore bird sanctuary "Eastern German Bight" records very low populations only in summer and autumn compared to the entire German North Sea (MENDEL et al. 2008).

2.9.2.3 Occurrence of seabirds in the nature reserve "Sylt Outer Reef - Eastern German Bight

By decree of 22 September 2017, the nature reserve (NSG) "Sylt Outer Reef - Eastern German Bight" was placed under protection as a complex area under national law. It covers a total area of 5,603 km2. Sub-area II of the NSG corresponds to the bird sanctuary "Eastern German Bight", which was designated as a nature reserve with effect from 24.0.2005 and included in the list of specially protected areas (SPA) as a bird sanctuary (DE 1011-401). Sub-area II covers an area of 3,140 km2 Six species of Annex I of the European Birds Directive are found in Sub-area II: red-throated diver, black-throated diver, little gull, sandwich tern, common and Arctic tern. Regularly occurring migratory species include fulmar, gannet, common scoter, skua, black-backed gull, common gull, herring gull, kittiwake. Guillemot and Razorbill (Sec. 5 para. 1 nos. 1 and 2 NSGSylV).

In the context of the description and status assessment of the nature reserve "Sylt Outer Reef - Eastern German Bight" (BfN 2017), species-specific population figures were determined for the entire complex area and not separately for sub-area II. In the textual explanations in BfN (2017), it is explained for most species, especially those with a large-scale occurrence or with a tendency to occur closer to the coast, that the populations are concentrated in sub-area II in the seasons of high occurrence. Table 13below lists the populations identified in BfN (2017), with the exception of the Common Diver populations in spring, for the species protected under the conservation objectives of Subarea II in the high occurrence seasons.

Table 1213: Populations of protected bird species in the nature reserve "Sylt Outer Reef - Eastern German Bight" in the seasons of high occurrence according to BfN (2017). Spring population of the red-throated diver in subarea II according to Schwemmer et al. (2019).

German name (*scientific Name*)	**Season**	**Stock NSG "Sylt Outer Reef - Eastern German Bight**
Red-throated diver (*Gavia stella*)	Spring	6.000
Black-throated diver (*Gavia arctica*)	Spring	210
Sandwich Tern (*Thalasseus sandvicensis*)	Spring	1.900
Arctic tern (*Sterna paradisaea*)	Spring	120
	Summer	160
Common Tern (*Sterna hirundo*)	Summer	180
Little Gull (*Hydrocoloeus minutus*)	Spring	3.000
Kittiwake (*Rissa tridactyla)*	Spring	4.200
	Winter	3.900
Herring Gull (*Larus fuscus*)	Autumn	4.700
	Summer	4.800
Common gull (*Larus canus*)	Winter	4.600
Common Scoter (*Melanitta nigra*)	Winter	15.000
Tordalk (*Alca torda*)	Autumn	4.500
	Winter	2.000
Guillemot (*Uria aalge*)	Autumn	4.700
	Winter	6.000
Gannets (*Morus bassanus*)	Spring	330
	Summer	300
fulmars (*Fulmarus glacialis*)	Spring	2.300
	Summer	2.700

German name (*scientific Name*)	Season	Stock NSG "Sylt Outer Reef - Eastern German Bight
Skua (*Stercorarius skua*)	Summer	6-10
Pomarine Skua (*Stercorarius pomarinus*)	Spring	1-5

2.9.2.4 Occurrence of divers in the main concentration area

In 2009, the main concentration area of common divers in the German Bight was defined on the basis of all data available at that time from environmental impact studies for offshore wind farms, from research projects and from Natura2000 monitoring (BMU 2009).

The main concentration area takes into account the particularly important period for the species, red-throated and black-throated divers, the spring. Based on the data available at the time the main concentration area was defined in 2009, the main concentration area accommodates approx. 66% of the diver population in the German North Sea or approx. 83% of the EEZ population in spring and is therefore particularly important in terms of population biology (BMU 2009). Current population calculations for the more dominant species of red-throated diver yield mean populations of approx. 11,000 individuals for the main concentration area in spring (SCHWEMMER et al. 2019, BIOCONSULT SH et al. 2020).

The main concentration area covers an area of 7,036 km2. It includes all areas of very high diver density and most of the areas of high diver density. The delineation of the main diver concentration area is based on the data situation, which is considered to be very good, and on technical analyses that find broad scientific acceptance. It is known from more detailed analyses and further studies that diver occurrences are subject to high temporal and spatial dynamics. The use of the different areas of the main concentration area can be related to the also highly dynamic frontal systems in the eastern German Bight (SKOV & PRINS 2001, Heinänen ET al. 2018). The delimitation of the main concentration area in the west and southwest was chosen to include all important and known regular occurrences. However, especially during the spring migration of the species from the wintering to the breeding grounds, irregular occurrences occur again and again west of the boundary of the main concentration area and also in the EEZ north of the East Frisian Islands, which, however, are not likely to be part of a larger, contiguous area regularly used at medium to very high densities (BMU 2009). Findings from research and monitoring confirmed that the occurrence north of the East Frisian Islands is significantly lower and less persistent (GARTHE et al. 2015, IFAÖ ET AL. 2016, IFAÖ et al. 2017).

2.9.2.5 Occurrence of seabirds and resting birds in the areas for wind energy

The areas for offshore wind energy in the North Sea identified in the spatial plan can be described in more detail with regard to the occurrence of seabirds, as extensive data from environmental impact studies and monitoring of offshore wind farm projects during construction and operation are available. The data are based on many years of ship- and aircraft-based surveys. Due to the large-scale surveys, the findings from these studies can be assumed to be representative for the seabird communities in individual sub-areas or zones of the EEZ.

Areas EN1, EN2, EN3 (Zone 1)

The extensive seabird surveys carried out as part of environmental impact studies and during the construction and operational phases of offshore wind farms consistently show that a seabird community can be found here. operational phases of offshore wind farms consistently show for areas EN1, EN2 and EN3 and their surroundings that a seabird community can be found here as would be expected for the prevailing water depths and hydrographic conditions, distance from the coast and site-specific influences (IFAÖ et al. 2015a, IFAÖ ET AL. 2015b, IfAÖ et al. 2016, IFAÖ ET AL. 2017, IFAÖ ET AL. 2018, , IFAÖ ET AL. 2019b). Seabird abundance is dominated by gulls, especially those known to be ship-followers and to benefit from fisheries waste (e.g. herring gull). Lesser Black-backed Gulls occur only sporadically, while Common Gulls occur independently of fishing activities in autumn and winter. High-sea bird species such as guillemot and razorbill are among the most common species, along with kittiwake and herring gull. In contrast, coastal bird species such as terns and ducks are only found in small numbers and only fly during the main migration periods. For diving sea ducks, the areas are not particularly important as feeding grounds due to the water depth. Their occurrence is concentrated in the shallow water areas near the coast south of areas EN1 to EN3 (BIOCONSULT SH & IFAÖ 2014, IFAÖ ET al. 2015a, IfAÖ et AL. 2015b, IfAÖ ET AL. 2016, IfAÖ ET AL. 2017, IfAÖ et al. 2018, , IfAÖ ET AL. 2019b). Divers use this nearshore area of the EEZ mainly in winter and spring. Surveys show that the distribution of divers is concentrated within the 12 nautical mile zone off the East Frisian Islands. However, they also sporadically occur within and in the vicinity of areas EN1 to EN3 (GARTHE et al. 2015, IFAÖ ET AL. 2016, IFAÖ ET AL. 2017, IFAÖ ET AL. 2018, IFAÖ ET AL. 2019b). In recent evaluations of the FTZ, a larger occurrence to the south-east of area EN3 can be identified (GARTHE et al. 2018).

All in all, a consideration of all available data suggests a species-specific different use of the three sub-areas. There are no focal occurrences to be identified. Species-specific density gradients (e.g. near the coast versus far from the coast) and seasonal distribution patterns can be identified. All studies to date also highlight the strong interannual variability of bird occurrence in this area.

Area EN4 (Zone 1)

The data from the vicinity of site EN4 show a medium, occasionally high occurrence of seabirds. The entire area of the eastern German Bight, in which site EN4 is located, is of high importance for a total of six species (groups). This concerns red-throated and black-throated divers, lesser black-backed gulls, common gulls, common scoters and terns (common, Arctic and Sandwich terns).

However, due to the water depth of more than 20 m, scoters are rarely or not at all observed in the area of EN4. In recent surveys, dense occurrences of Common Scoters have only been observed in the extreme north-eastern edge of the EN4 study area (IBL UMWELTPLANUNG et al. 2016b, IBL UMWELTPLANUNG ET AL. 2017a, IBL UMWELTPLANUNG et al. 2018). Common gulls occur in and around site EN4 mainly in autumn and winter, mostly over large areas. Lesser Black-backed Gulls can occur all year round in the area of site EN4, but are most common in spring and winter. Terns mainly occur during migration periods. In recent surveys, occurrence was concentrated in the north of Area EN4 (IBL UMWELTPLANUNG et al. 2017a, IBL UMWELTPLANUNG et al. 2018). Area EN4 is located in the southern part of the main spring concentration area of common divers (BMU 2009). In the species-specific spring, from March to May, divers are regularly observed in higher densities in the vicinity of the site, mainly northwest and east of EN4 (IBL UMWELTPLANUNG et al. 2017a, IBL UMWELTPLANUNG ET AL. 2018, IBL UMWELTPLANUNG ET AL. 2019).

The most abundant species are herring gulls, kittiwakes - especially in association with fishing activities -, gulls - independent of fishing activities, especially in autumn and winter in high densities - and alcids. The latter, mainly guillemot and razorbill, occur only on average in the vicinity of Area EN4, compared to the offshore areas of the EEZ. The immediate vicinity of Area EN4 is partly used as a feeding ground in summer by breeding birds from Helgoland's breeding colonies. Northern fulmars and gannets occur rather sporadically (IBL UMWELTPLANUNG et al. 2016b, IBL UMWELTPLANUNG ET AL. 2017a, IBL UMWELTPLANUNG ET AL. 2018, IBL UMWELTPLANUNG ET AL. 2019).

Area EN5 (Zone 2)

The area surrounding site EN5 has a high occurrence of seabirds. All results so far show a gradient in the composition of the bird community: the area east of site EN5 marks the transition between nearshore areas with water depths below 20 m to areas with increasing water depth and distance from the coast. The vicinity of EN5 thus has a mixed bird community with a high proportion of shorebirds in nearshore areas, transitioning to an upland bird community to the west with increasing water depth (BIOCONSULT SH 2015). In recent surveys, common scoter was the most common species in the study area in the nearshore area east of site EN5 in both vessel-based and digital aircraft-based surveys (BIOCONSULT SH 2017, BioConsult SH 2018, BIOCONSULT SH 2019, BioConsult SH 2020). In the immediate vicinity of area EN5, open sea species dominate with kittiwakes, *Larus gulls* and alcids. To the west of site EN5, fulmars also occur in late winter and summer (IFAÖ 2016a, IFAÖ 2017). Gannets occur in the vicinity of EN5 only in small numbers during migration periods or in summer (IFAÖ 2017, BIOCONSULT SH 2018, BIOCONSULT SH 2019, BIOCONSULT SH 2020).

Species according to Annex I of the Birds Directive (Birds Directive) occur regularly. All subareas of site EN5 are located in the main concentration area of divers in spring in the German Bight (BMU 2009). From March to mid-May (species-specific spring), high densities with pronounced intra- and interannual variability are recorded in the area around site EN5 (GARTHE et al. 2015, GARTHE et al. 2018, BIOCONSULT SH ET AL. 2020). According to current surveys, the occurrence of common divers is concentrated east of site EN5 within the bird sanctuary in southern and northern extent as well as south of site EN5. In the other seasons, divers are observed only sporadically (BIOCONSULT SH 2017, IFAÖ 2017, BIOCONSULT SH 2018, IFAÖ 2018, BIOCONSULT SH 2019, IFAÖ 2019b, BIOCONSULT SH 2020). Lesser black-backed gulls occur mainly during migration periods and in winter in low densities in the area of site EN5. Densities increase from west to east. Terns have been observed east of Area EN5 during migration periods and sporadically in summer (BIOCONSULT SH 2017, IFAÖ 2017, BIOCONSULT SH 2018, IFAÖ 2018, BioConsult SH 2019, IFAÖ 2019b, BIOCONSULT SH 2020).

Areas EN6 to EN13 (zones 2 + 3)

Areas EN6 to EN13 north of the traffic separation areas have a medium to seasonally high occurrence of seabirds. The species spectrum and especially the abundance ratios identify these areas as typical habitats of the seabird community. The most common species are guillemot, kittiwake, razorbill and herring gull. Gulls are observed here mainly hunting for fishing waste. Gulls occur in small numbers in autumn and winter regardless of fishing activities. Northern fulmars and gannets are observed year-round in this part of the EEZ. However, the occurrences show strong intra- and interannual fluctuations (PLANUNGSGEMEINSCHAFT UMWELTPLANUNG OFFSHORE WINDPARK 2015, IBL UMWELTPLANUNG et al. 2016a, IBL UMWELTPLANUNG et al. 2017b, Planungsgemeinschaft Umweltplanung

Offshore WINDPARK 2017, PLANUNGSGEMEINSCHAFT UMWELTPLANUNG OFFSHORE WINDPARK 2018, IBL UMWELTPLANUNG et al. 2018).

Species of Annex I of the V-RL may occur sporadically in the areas EN6 to EN13 during migration periods and in winter. The occurrence of lesser black-backed gulls, terns and divers does not indicate any focal points. This area of the EEZ serves as a migration area for them (IBL UMWELTPLANUNG et al. 2017b, PLANUNGSGEMEINSCHAFT UMWELTPLANUNG OFFSHORE WINDPARK 2017, PLANUNGSGEMEINSCHAFT UMWELTPLANUNG OFFSHORE WINDPARK 2018, IBL UMWELTPLANUNG et al. 2018). Compared to the main concentration area, only low diver densities have been recorded in the adjacent areas in spring so far (IFAÖ 2016b).

Due to the water depth, the areas have no significance as resting and feeding habitats for diving sea ducks, which seek their food on the seabed. Many of the exclusively piscivorous seabird species found here forage diving in the water column. These species are attracted by concentrated occurrences of fish as well as macrozooplankton.

Due to their nature, areas EN6 to EN13 belong to the large-scale habitat of the Common Guillemot in the North Sea. Common guillemots can occur there in large numbers, especially in autumn and winter. Studies in the context of environmental impact studies and monitoring have shown the occurrence of juvenile guillemots in this area of the EEZ during the post-breeding season (MARKONES & GARTHE 2011, Markones ET al. 2014, PLANUNGSGEMEINSCHAFT UMWELTPLANUNG OFFSHORE WINDPARK 2015). During this period, their occurrence depends primarily on the ocean current and is therefore variable. Moreover, guillemots are not bound to specific habitats outside the breeding season (CAMPHUYSEN 2002, DAVOREN et al. 2002, VLIESTRA 2005, CRESPIN ET AL., 2006, FREDERIKSEN ET AL. 2006). This is supported by:

- the potential resting and foraging habitat, which extends across the entire North Sea, based on the large-scale distribution in the EEZ,
- the high mobility also during the leadership of young birds and
- the high spatial and temporal variability of occurrence that has been observed several times.

Areas EN14 to EN 19 (zones 4 + 5)

The seabird monitoring surveys conducted by the FTZ on behalf of the BfN provide information on the seabird community in areas EN14 to EN19 in the so-called "duck's bill". This area is one of the typical habitats of seabird species. Northern fulmars and kittiwakes occur all year round, with a focus in spring and winter, respectively. Razorbills and guillemots are most numerous in winter, the latter also occurring in spring in this remote area of the EEZ. The Dogger Bank area within the German EEZ is part of the foothills of the range of the puffin (*Fratercula arctica*). However, the occurrence within the EEZ is very low (BFN 2017, BORKENHAGEN et al. 2017, BORKENHAGEN ET AL. 2018, BORKENHAGEN ET AL. 2019).

2.9.3 Status assessment of seabirds and resting birds

The high survey effort of the past years and the current state of knowledge allow a good assessment of the importance and condition of individual sub-areas and areas as habitats for seabirds. This importance results from the assessments of occurrence and spatial units or functions. In addition, the criteria of protection status and existing pressures at a higher level are considered.

2.9.3.1 Protection status

Table 15below summarises the classification of the most common resting bird species in the EEZ into national and international endangerment categories.

Table 1415: Assignment to the endangerment categories of the European Red List of the most important resting bird species in the German EEZ in the North Sea. IUCN definition: LC = Least Concern; NT = Near Threatened; VU = Vulnerable; EN = Endangered; CR = Critically Endangered (BIRDLIFE INTERNATIONAL 2015a). Definition according to SPEC: SPEC 3 = not restricted to Europe but with negative population trends and unfavourable conservation status. SPEC 1 = European species in need of global conservation action, i.e. classified as Critically Endangered, Endangered, Vulnerable, Near Threatened or Data Deficient on a global scale (BIRDLIFE INTERNATIONAL 2015b).

German name (*scientific Name*)	**Annex IV-RL1**	**Red List (Europe)[2]**	**Red List (EU27)[2]**	**SPEC3**
Red-throated diver *(Gavia stellata)*	X	LC	LC	3a
Black-throated diver *(Gavia artica)*	X	LC	LC	3a
fulmar *(Fulmarus glacialis)*		EN	VU	3b
Gannets *(Morus bassanus)*		LC	LC	
Common Scoter *(Melanitta nigra)*		VU	VU	
Great black-backed gull *(Larus marinus)*		LC	LC	
Herring Gull *(Larus fuscus)*		LC	LC	
Common gull *(Larus canus)*		LC	LC	
Little Gull *(Hydrocoloeus minutus)*	X	NT	LC	3a
Kittiwake *(Rissa tridactyla)*		VU	EN	3b
Sandwich Tern *(Thalasseus sandvicensis)*	X	LC	LC	
Common Tern *(Sterna hirundo)*	X	LC	LC	
Arctic tern *(Sterna paradisea)*	X	LC	LC	

German name (*scientific Name*)	Annex IV-RL1	Red List (Europe)[2]	Red List (EU27)[2]	SPEC3
Guillemot *(Uria aalge)*		NT	LC	3b
Tordalk *(Alca torda)*		NT	LC	1b

[1] Annex 1 V-RL

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

[3] BIRDLIFE INTERNATIONAL (2015b) European Birds of Conservation Concern

aHibernation

bBreeding

2.9.3.2 Preloads

As part of the marine ecosystem, seabirds are exposed to many pressures that may pose a potential threat but also influence their occurrence and distribution. Changes in the ecosystem may be associated with 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 fish fauna, among other things. Plankton and fish fauna serve as a food source for seabirds. However, due to the uncertainty regarding the effects of climate change on the individual ecosystem components, it is hardly possible to predict the effects of climate change on seabirds.
- ***Fisheries***: Fisheries can be expected to have a strong influence on the composition of the seabird community in the EEZ. Fishing can reduce the food supply or even limit it. 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 (herring, herring gull, storm-petrel and black-headed gull) has been identified by targeted surveys (GARTHE et al. 2006).
- ***Shipping***: Shipping traffic can exert scaring effects 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 species sensitive to disturbance as shipping traffic. In addition, there is an increase in the volume of shipping traffic, e.g. due to supply runs. There is also a risk of collision with such structures.
- ***Other existing pressures:*** In addition, eutrophication, the accumulation of pollutants in marine food chains and rubbish floating in the water, e.g. parts of fishing nets and plastic parts, can affect the occurrence and distribution of seabirds. Epidemics of viral or bacterial origin can pose a threat to populations of seabirds and resting birds.

In summary, the seabird community of the German EEZ of the North Sea is clearly subject to anthropogenic influence. The seabird community in the EEZ cannot be considered natural for the reasons mentioned here.

2.9.3.3 Significance of sub-area II of the nature reserve "Sylt Outer Reef - Eastern German Bight

Sub-area II of the Sylt Outer Reef - Eastern German Bight National Park has an outstanding function in the German Bight as a feeding, wintering, moulting, migrating and resting area for species listed in Annex I of the Birds Directive that occur there (in particular red-throated divers, black-throated diver, little gull, Sandwich, common and Arctic tern) and regularly occurring migratory bird species (in particular storm and herring gull, fulmar, gannet, kittiwake, guillemot and razorbill and common scoter).

The importance of individual parts of the nature reserve for resting and migratory birds varies from year to year as a result of the hydrographic conditions and weather patterns. Within the bird sanctuary, numerous migratory and resting birds use the existing high biomass. In particular, the biomass of the mixed zone (roughly along the 20 m depth contour) between estuarine and open waters is a temporarily abundant food source.

2.9.3.4 Significance of the main concentration area for divers in the German Bight

The main concentration area represents a particularly important component of the marine environment with regard to seabirds and resting birds, especially with regard to the diver species group.

It is the most important resting area for divers in the German North Sea during the busy spring. Every year, several thousand divers, mainly red-throated divers, stop over in the area on their way to the breeding grounds.

Against the background of current stock calculations, the importance of the main concentration area for divers in the German North Sea and within the EEZ remains high (Schwemmer et al. 2019, BioConsult SH et al. 2020).

Since 2009, the BSH has carried out the qualitative assessment of cumulative effects on divers within the framework of approval procedures, using the main concentration area in accordance with the position paper of the BMU (2009) (see Chapter 4.11.4).

2.9.3.5 Importance of areas for offshore wind energy for seabirds and resting birds

Areas EN1, EN2, EN3 (Zone 1)

Bird species listed in Annex I of the V-Directive, such as divers, terns and lesser black-backed gulls, use the area of sites EN1 to EN3 as a feeding ground only on average and mainly during migration periods. For them, the vicinity of these areas does not count as valuable resting habitats or preferred staging areas in the German Bight.

For breeding birds, areas EN1, EN2 and EN3 are of no importance due to the distance to the coast and to the islands with breeding colonies as feeding grounds.

Abundance and distribution of seabirds show species-specific high interannual variability within the three areas, with small-scale variability occurring within the areas.

The most common species are ship-followers that benefit from fishing waste. The pre-existing pressures from shipping, fishing and offshore wind farms in the vicinity of areas EN1, EN2 and EN3 are of medium to partly high intensity for seabirds. According to current knowledge, the three areas EN1, EN2 and EN3 are of medium importance for resting and foraging birds.

The overall medium importance of the areas for seabirds and resting birds results from the assessment of the protection status, occurrence, spatial unity and pre-existing pressures on seabird occurrence in the area between the traffic separation areas in the German Bight.

Area EN4 (Zone 1)

Area EN4 is located in the immediate vicinity of the nature reserve "Sylt Outer Reef - Eastern German Bight" and in the southernmost area of the main concentration area of divers in spring in the German Bight (BMU 2009). The surroundings of site EN4 are thus of high importance for divers, even though densities are mostly below those recorded in the area of the protected area and in the areas northwest of site EN4.

Other bird species listed in Annex I of the V-Directive, such as terns and lesser black-backed gulls, occur on average in site EN4. For the other seabird species to be protected in the protected area, the surroundings of site EN4 are in part of high importance. The abundance and distribution of seabirds within the area show high interannual variability. The area is of medium to high species-specific importance as a feeding ground. For seabirds, the impact of shipping, fishing and offshore wind farms in this area is of medium to high intensity depending on the season. For breeding birds from the breeding colonies on Helgoland and on the islands off the North Frisian coast, site EN4 is of low to medium importance as a feeding ground due to its distance.

Area EN5 (Zone 2)

All findings so far indicate a high importance of site EN5 for seabirds.

For the red-throated and black-throated divers listed in Annex I of the V-RL, the surroundings of site EN5 are of very high importance. All sub-areas are located in the main concentration area of divers in the German Bight in spring (BMU 2009). To the east of site EN5 is sub-area II of the nature reserve "Sylt Outer Reef - Eastern German Bight" (Ordinance of 27.09.2017, Federal Law Gazette Part I No. 63, 3423). Here - seasonally and species-specifically - a high occurrence has also been recorded for other protected seabird species. Other bird species listed in Annex I of the V-Directive, such as terns and lesser black-backed gulls, also occur in site EN5.

Site EN5 and its surroundings lie in the transitional range of many coastal bird species, such as diving sea ducks, within the bird sanctuary, as well as an increasing occurrence of deep-sea bird species to the west of the site. The abundance and distribution of bird species within the site show high interannual variability. The area around the site is of medium, but at times also high, importance as a feeding ground for many species of seabirds. For divers, the area EN is of high importance as a feeding ground before the migration to the breeding grounds in spring.

For breeding birds, area EN5 has only low importance due to the distance to the coast and to the islands with the breeding colonies as feeding grounds. The impacts of shipping, fishing and offshore wind farms in and around area EN5 are of medium to high intensity for seabirds.

Areas EN6 to EN13 (Zones 2 + 3)

All findings to date indicate a medium importance for seabirds for the areas north of the traffic separation areas. Overall, the areas have a medium seabird occurrence. The areas are most frequently used by seabird species that are widely distributed throughout the North Sea, including ship-followers that benefit from bycatch.

Species sensitive to disturbance, such as divers, are only present in the areas for a short time when foraging and during the main migration periods. The areas are located outside the main distribution area of the divers in spring. For other species of seabirds listed in Annex I of the Birds Directive and requiring special protection, the areas are also not among the valuable resting habitats or preferred staging areas in the German Bight. The abundance and distribution of seabirds show high interannual variability within the areas. The areas are of medium importance as feeding grounds for seabird species. Due to their distance from the coast, areas EN6 to EN13 are not important for breeding birds. The existing impacts from shipping and fishing in the areas are of medium to partly high intensity for seabirds. Due to the previous development of individual areas (EN6 and EN8), the existing impact of offshore wind farms in areas EN6 to EN13 is generally considered to be low.

Areas EN14 to EN19 (zones 4 + 5)

Areas EN14 to EN19 belong to the typical habitat of deep-sea bird species such as fulmars, guillemots and kittiwakes. Due to the distance from the coast, it can be assumed that the areas are not important for breeding birds. There is currently no sufficiently up-to-date data available for a detailed assessment of the general seabird occurrence or the occurrence of other (high) seabird species in this area of the EEZ. It is assumed that future studies and monitoring programmes will increasingly focus on this area of the EEZ and thus expand the data base.

2.9.3.6 Conclusion

The EEZ of the North Sea can be subdivided into different sub-areas, each of which has a seabird occurrence to be expected for the prevailing hydrographic conditions, the distances to the coast, the existing existing pressures and species-specific habitat requirements.

2.10 Migratory birds

Bird migration usually refers to periodic migrations between the breeding area and a separate non-breeding area, which for birds at higher latitudes usually includes the winter quarters. Since bird migration takes place annually, it is also called annual migration - and is widespread worldwide. In this context, we also speak of two-way migrants, which make an outward and return journey, or annual migrants, which migrate every year. Often, in addition to a resting destination, one or more intermediate destinations are visited, be it for moulting, to find favourable feeding areas or for other reasons. According to the distance covered and physiological criteria, a distinction is made between long-distance and short-distance migrants.

2.10.1 Data situation

Surveys of bird migration over the south-eastern North Sea were already carried out on Helgoland in the 19th century (Gätke 1900). Long-term observation series on migration phenology and species-specific changes are available, especially for species whose habitat requirements are met by the Fanggarten (HÜPPOP & Hüppop 2002, 2004). In addition, visual observations and surveys at coastal sites (e.g. HÜPPOP et al. 2004, 2005) as well as visual observations carried out at various offshore sites provide quantitative data on bird migration (MÜLLER 1981, DIERSCHKE 2001).

Accompanying ecological research, environmental impact studies (EIS) and the monitoring of offshore wind farm projects during construction and operation provide the most up-to-date data on bird migration over the German Bight and complement fundamental work. Particularly worthy of mention are the bird migration surveys on FINO1, which began in 2003 and allow largely continuous radar measurements of bird migration in the offshore area with constant conditions. Extensive results were published in the reports BeoFINO (OREJAS et al. 2005) and FINOBIRD (HÜPPOP et al. 2009). In addition, historical data on approach and collision events of birds at formerly manned lighthouses and lightships (e.g. BLASIUS 1885 - 1903, BARRINGTON 1900, HANSEN 1954) can provide valuable information on bird migration across the North Sea. Within the framework of the accompanying ecological research, further evaluations of such records were also carried out on lighthouses and lightships in the German Bight (BALLASUS 2007).

2.10.1.1 Spatial distribution and temporal variability of migratory birds

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

According to KNUST et al. (2003), this also applies to the North Sea and Baltic Sea. Species migrating at night in particular, which cannot be guided by geographical structures due to darkness, move across the sea in broad-front migration.

Seasonal migration intensity is closely linked to species- or population-specific life cycles (e.g. BERTHOLD 2000). In addition to these largely endogenously controlled annual rhythms in migratory activity, the concrete course of migration is primarily determined by weather conditions. Weather factors also influence the altitude and speed at which birds migrate. In general, birds wait for favourable weather conditions (e.g. tailwind, no precipitation, good visibility) for their migration in order to optimise it in an energetic sense. As a result, bird migration is concentrated on individual days or nights in autumn or spring. According to the results of an R&D project (Knust ET al. 2003), half of all birds migrate in only 5 to 10% of all days. Furthermore, migration intensity is also subject to diurnal fluctuations. About two thirds of all bird species migrate mainly or exclusively at night (HÜPPOP et al. 2009).

Broad-front migration is typical for night migration of songbirds, but also for day migration. A current cross-project evaluation of all data from large-scale bird migration monitoring for offshore wind farm projects showed a gradient of decreasing migration intensities with greater distance from the coast for the nocturnal migration of songbirds over the North Sea, which is dominated by songbirds (WELCKER 2019a). For a number of songbirds primarily migrating during the day, a lower migration intensity can be observed on Helgoland than on Sylt or Wangerooge (OREJAS et al. 2005, HÜPPOP et al. 2009). Radar surveys confirm a decreasing intensity of limni migration towards the offshore area (DAVIDSE et al. 2000; LEOPOLD ET AL. 2004; HÜPPOP ET AL. 2006). The comparative studies by DIERSCHKE (2001) of the visible diurnal migration of waders and waterbirds between Helgoland and the (former) North Sea Research Platform (FPN) 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 visual observation results presented show a clear concentration of waterbirds close to 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, short-billed goose).

However, reliable information on the magnitude of the decrease is not possible due to the methodological requirements. Uncertainties in the visual observations result, for example, from a lack of knowledge about the proportion of migrants at higher altitudes. Furthermore, among waterbirds, species such as red-throated diver or short-billed goose stand out, which are observed at Helgoland with the same or higher number of individuals than from Sylt or Wangerooge (HÜPPOP et al. 2005, 2006). Table 17exclusively illustrates the differences in visible migration for Helgoland, Sylt and Wangerooge according to HÜPPOP et al. (2009). According to this, the intensity of bird migration is less reduced on Helgoland in autumn than in spring. A certain contribution to the relatively high intensities of Wangerooge and Sylt by local resting birds cannot be excluded. Furthermore, it should be considered that the difference existing for songbirds should be significantly weaker if night migration is taken into account at the same time.

Table 1617: Mean migration intensity (Ind/h) over sea in the first three hours after sunrise for all species combined at the three sites Wangerooge, Helgoland and Sylt for spring and autumn (HÜPPOP et al. 2009).

Seawatching	Spring	Autumn
Wangerooge	598,4	305,9
Heligoland	144,3	168,8
Sylt	507,2	554,2

Although the migration intensity of selected species and species groups decreases with distance from the coast, overall there is a broad-front movement across the open sea. Again, the special position of distinct nocturnal migrants should be noted, for which there is hardly any knowledge of decreasing migration intensity with coastal distance. At least, far fewer nocturnal migrants are recorded by radar on FINO1 than on Helgoland (HÜPPOP et al. 2009). Finally, the numbers of individuals documented on individual migration nights with > 100,000 and 150,000 songbirds (primarily thrushes) at FPN and the *Buchan Platform in the* central North Sea should also be emphasised (MÜLLER 1981, ANONYMUS 1992). They provide evidence of mass migration far from the coast and speak against pronounced gradients in migration intensity for these species, at least temporarily. The frequency of such mass migration in the offshore area and the total proportion of the migration of a biogeographical population attributable to it have not yet been clarified (BUREAU WAARDENBURG 1999; HÜPPOP et al. 2006).

2.10.1.2 Bird migration over the German Bight

Bird migration over the German Bight has been documented throughout the year using various methods (radar, seawatching, migratory call recording), although there are strong seasonal fluctuations, with focal points in spring and autumn. The German Bight is crossed synchronously (broad-front migration). According to EXO et al. (2002), many birds cross the North Sea in a broad front.

EXO et al. (2003) and HÜPPOP et al. (2005) specify the number of birds migrating annually across the German Bight at several 10-100 million. The largest proportion is made up of songbirds, the majority of which cross the North Sea at night (HÜPPOP et al. 2005, 2006). The bulk of the birds come from Norway, Sweden and Denmark. For waterbirds and waders, however, breeding ranges extend far northeast into the Palearctic and north and northwest to Svalbard, Iceland and Greenland.

Estimates of the annual migration volume over the North Sea by BUREAU WAARDENBURG (1999) for a larger selection of species involved in migration confirm the rough assumptions. For the sum of 95 selected species, BUREAU WAARDENBURG (1999) estimates a minimum number of > 40.91 million and a maximum number of > 152.15 million birds migrating annually over the North Sea.

The German Bight is on the migration route of numerous bird species. Between 226 and 257 (on average 242) species per year were recorded on Helgoland from 1990 to 2003 (according to DIERSCHKE et al. 1991-2004, cited in OREJAS et al. 2005). Other species that migrate at night but do not or rarely call, such as the Pied Flycatcher (HÜPPOP et al. 2005), must also be included. If rarities are included, a total of more than 425 migratory bird species have been recorded on Helgoland 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 seems to decrease (DIERSCHKE 2001).

Night migration is particularly pronounced in spring from mid-March to May and in autumn in October and November (HÜPPOP et al. 2005, AVITEC RESEARCH GBR 2015). The nocturnal surveys from the former North Sea Research Platform and the island of Helgoland confirm that nocturnal bird migration is concentrated on nights with favourable migration conditions during the main migration periods and then takes the form of mass migration. In spring, more than 50% of the radar-detectable migration was recorded on only 11 nights; in autumn 2003 and 2004, more than 50% of the migration occurred on five out of 31 and six out of 61 measurement nights, respectively (HÜPPOP et al. 2005). Low intensities are recorded from December to February and from June to August.

Migration intensity follows a distinct diurnal rhythm. Results of the automatic migratory call recording on FINO1 show an increasing migratory activity in the evening and night hours, which reaches its maximum in the early morning hours (HÜPPOP et al. 2009, HILL & HILL 2010). During the migration schedule observations, the highest migration intensity was also observed in the early morning hours and then ebbed away towards midday (HILL & HILL 2010, Avitec RESEARCH GBR 2015). The expression of this rhythm can vary depending on the location and season.

Figure 49shows a detailed section on the broad-frontal draught over the south-eastern North Sea. It should be emphasised here that the distances between the lines of individual migratory flows merely indicate the direction of a gradient. Therefore, conclusions about the magnitude of the spatial trends must not be drawn from Figure 49 The thickness of the lines also only qualitatively illustrates differences in intensity between the migratory flows.

According to current knowledge, the seasonal north-east-south-west or south-west-north-east migration dominates over a wide area (see Figure 50), although there may be certain differences in the direction of migration and the degree of coastal orientation. HÜPPOP et al. (2009) and AVITEC RESEARCH GBR 2015 also found a clear main direction of migration south-southwest in their investigations using radar on the FINO1 research platform in autumn (migration away) (see Figure 50). However, the results only reflect the conditions in good weather. In spring, a clear direction (north-east) was also discernible, but only at night when no foraging birds were active.

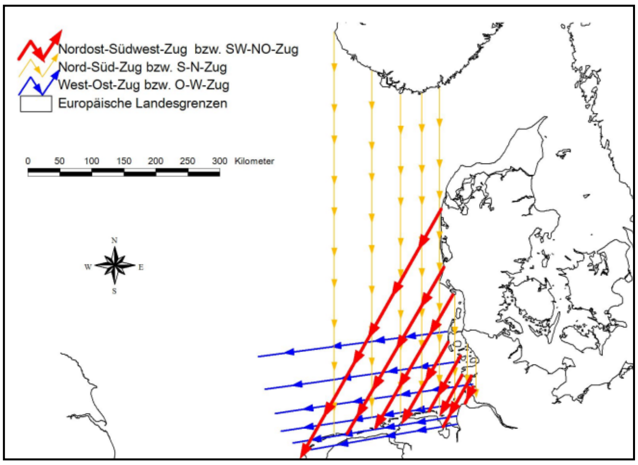


Figure 39: Schematic of main migration routes over the south-eastern North Sea (shown for autumn from HÜPPOP et al. 2005a).

Radar recordings at the EIS sites also confirm this main direction of migration, but there are some variations in the direction of migration per site. In northern areas far from the coast (Area 5), larger southbound and northbound migration shares were observed in autumn and spring, respectively. However, the EIS observations were made in short time windows. Further statements on spatial differences in the proportion of migratory directions that deviate from the main north-east-southwest direction of migration are therefore not possible at present (HÜPPOP et al. 2005a).

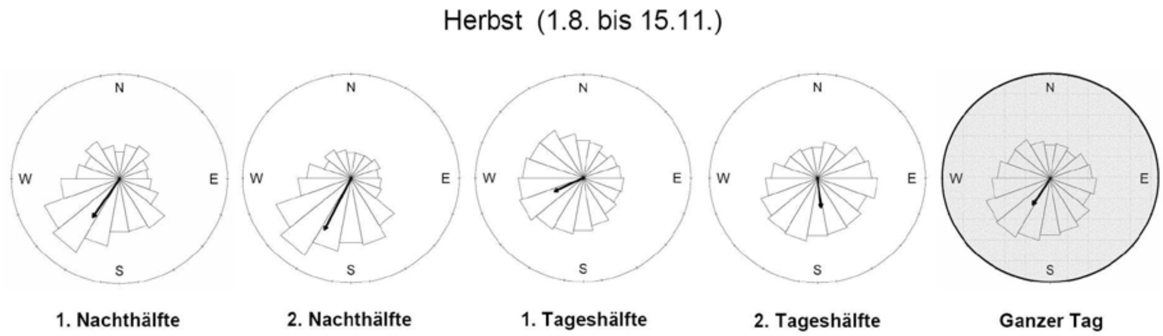


Figure 40: Relative proportions of the determined flight directions for the FINO1 research platform in autumn, for four times of day and for the whole day (grey), averaged over the years 2005 to 2007. The sum of the individual direction proportions within a circle graph is 100% in each case. The direction of the arrow in the centre of the circle indicates the average flight direction, the length of the arrow is a measure of its uniqueness (HÜPPOP et al. 2009).

The distribution of flight altitudes differs between the light and dark phases. In the dark phase, the flight and migration events take place on average at higher altitudes. The changes in altitude distribution in the light and dark phases are also due to the species involved and the behaviour of the species. As a rule, relatively high-flying migratory bird species primarily appear at night, while other, mostly lower-flying species (for example seabirds or gulls) end their flight activity at night and rest on the water or on land.

Most signals at FINO1 were recorded up to a height of 100 m in all seasons. In summer, the high flight activity in this range was mainly due to food-seeking individuals. The radar observations at the "alpha ventus" test site also show more intensive use of the altitude classes below 200 m. In spring 2009, 39% of the echoes were recorded in the height classes up to 200 m, and in autumn 2009 even 41% (HILL & HILL 2010). The values determined by AVITEC RESEARCH GBR (2015) in 2014 for the height classes up to 200 m are comparable at 36.1%. At night, especially in spring, more signals were registered in the upper altitude classes. EASTWOOD & RIDER (1965) and Jellmann (1989) also found higher flight heights in the North Sea area in spring than in autumn. However, migration above 1,500-2,000 m accounts for only a small proportion of the migratory events (JELLMANN 1979). However, the distribution of migration altitudes can differ greatly between individual nights and is strongly influenced by the current weather conditions (JELLMANN 1979, HÜPPOP et al. 2006).

2.10.1.3 Species composition

The flight or migration activity of the light phase is mostly dominated by species groups during the course of the year and during the migration phases, which use the area both as a resting area and as a migration area. Among these, the gulls, terns and seabirds with the species/collective groups herring gull, three-toed gull, storm gull, Arctic tern and common gannet reach the highest dominance values and/or continuities. Among the migratory bird species that exclusively cross the sea area, the majority of records concern songbirds.

While the songbirds pass through the project area quite concentrated and relatively directed in the main migration months, gulls are present almost all year round. This occurrence is often associated with fishing vessels or other ships.

With partly large populations, songbirds dominate the overall migratory events. During the FINOBIRD project, 97 species were detected on FINO1 via automatically recorded and manually analysed bird calls (N = 95,318 individuals) (HÜPPOP et al. 2009). Three quarters were calls of songbirds, especially thrushes. Meadow pipit, robin, chaffinch, winter goldcrest and skylark were also frequently represented in addition to the starling. The second most frequent species group (11%) was the group of terns (mainly Sandwich Tern). In the context of the migratory call surveys for "alpha ventus", the thrushes also formed the majority of the registered migratory calls (HILL & HILL 2010).

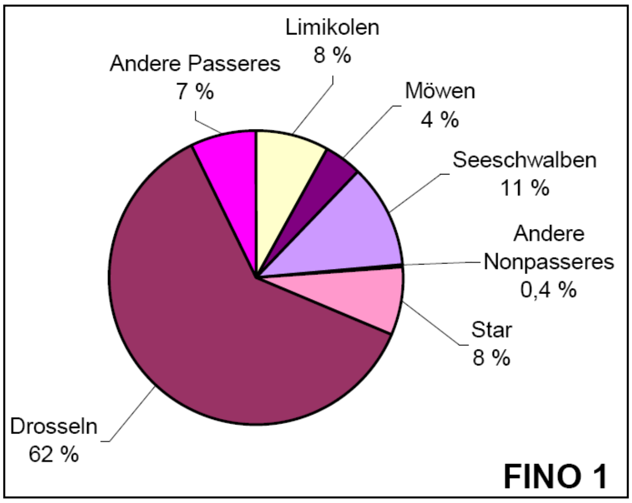


Figure 41: Proportions of species groups in all call surveys near the FINO1 research platform from 12.3.2004 to 1.6.2007 (HÜPPOP et al. 2012).

2.10.2 Status assessment of migratory birds as an object of protection

The assessment of the status of migratory birds in the EEZ of the German North Sea is based on the following assessment criteria:

-Large-scale importance of bird migration

-evaluation of the occurrence

-Rarity and vulnerability

• Preloads

2.10.2.1 Large-scale significance

According to current knowledge, several 10 - 100 million (max. 152 million) birds migrate across the German Bight every year. The largest proportion is made up of songbirds, the majority of which cross the North Sea at night and in broad-front migration. A current cross-project evaluation of all data from large-scale bird migration monitoring for offshore wind farm projects showed a gradient of decreasing migration intensities with greater distance from the coast for nocturnal bird migration over the North Sea, which is dominated by songbirds (WELCKER 2019). The majority of birds originate from Norway, Sweden and Denmark. For songbirds primarily migrating during the day, there are also indications of a decrease with distance from the coast, as Helgoland has in the past recorded a significantly lower migration intensity than Sylt (Hüppop et al. 2005). This trend is also confirmed for the migration of limicolts by radar surveys (Hüppop et al. 2006). The same seems to be true for waterfowl and wader migration (Dierschke 2001).

The definition of concentration areas and guidelines for bird migration cannot be seen on a small scale in the offshore area due to the lack of structures. An assessment of this criterion must take into account the large-scale course of bird migration in the North Sea.

2.10.2.2 Assessment of the occurrence

The migration of an estimated 40 to 150 million individuals is immense and it is likely that significant populations of songbirds breeding in northern Europe migrate across the North Sea.

A characteristic of nocturnal bird migration with a high number of individuals is the strong seasonal fluctuations in migration intensity, with a large part of the migratory activity taking place on only a few nights. In addition to the BeoFINO and FINOBIRD research projects cited above, this relationship is also regularly demonstrated in the course of environmental impact studies on offshore wind farms and in the context of construction- and operation-related monitoring.

2.10.2.3 Rarity and endangerment

The species spectrum of visible migration in the light phase in the area of the German Bight in

2003/2004 is estimated at 217 species. Other species that migrate at night must also be included.

Many bird species are listed in one or more of the following Conventions and Appendices on the Conservation Status of Central European Birds:

- Annex I of the V-Directive,
- 1979 Bern Convention on the Conservation of European Wildlife and Natural Habitats,
- Bonn Convention on the Conservation of Migratory Species of Wild Animals, 1979,
- AEWA (African-Eurasian Waterbird Agreement),
- SPEC (Species of European Conservation Concern).

SPEC ranks bird species according to Europe's population share and BirdLife International's threat level.

Of the species detected, 20 are listed in Annex I of the V-RL: Red-throated and black-throated diver, Sandwich, Common and Arctic tern, Little and Black tern, Short-eared owl, Marsh harrier, Hen harrier, Osprey and Merlin, Little gull, Golden plover, Ruff, Wood sandpiper and Bar-tailed godwit, Barnacle goose, Woodlark and Bluethroat.

The range of species of over 200 that migrate across the North Sea each year can be described as average compared to the 425 migratory bird species that have been recorded on Helgoland over the years so far. However, a very high proportion has an international protection status and is endangered throughout Germany. For these reasons, the North Sea EEZ has an average to above-average importance with regard to the criteria of number of species and endangerment status for bird migration.

2.10.2.4 Preloads

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

Major anthropogenic factors that increase the mortality of migratory birds are active hunting, collisions with anthropogenic structures and, for waterbirds and seabirds, environmental pollution by oil or chemicals (CAMPHUYSEN et al. 1999). The various factors act cumulatively, so that the detached significance is usually difficult to determine. Especially in Mediterranean countries, a statistically insufficiently recorded proportion of hunting still takes place (HÜPPOP & HÜPPOP 2002). TUCKER & HEATH (1994) conclude that more than 30% of the European species characterised by population declines are also threatened by hunting.

The proportion of birds ringed on Helgoland and of birds indirectly killed by humans has increased in the past in all species groups and regions of discovery, with building and vehicle approaches being the main causes (HÜPPOP & HÜPPOP 2002). Surveys of collision victims at four lighthouses in the German Bight show that songbirds strongly dominate. Starlings, thrushes (song thrush, redwing, juniper thrush) and blackbirds are particularly prominent among the dead. Similar findings are available for FINO1 (HÜPPOP et al. 2009), the FPN (MÜLLER 1981) or former lighthouses on the Danish west coast (HANSEN 1954). A total of 770 dead birds (35 species) were found during 36 out of 159 visits to the FINO1 research platform with bird monitoring between October 2003 and December 2007. Thrushes and starlings were the most common, accounting for 85% together. The species concerned are characterised by night migration and relatively large populations. It is striking that almost 50% of the collisions recorded at FINO1 occurred on only two nights. Both nights were characterised by south-easterly winds, which may have promoted migration over sea, and poor visibility, which may have led to a reduction in flight altitude and increased attraction by the illuminated platform (HÜPPOP et al. 2009). The surrounding area of site N-3.7 is partly already developed with wind farms.

Global warming and climate change also have measurable effects on bird migration, e.g. through changes in phenology or altered arrival and departure times, which, however, are species-specific and vary regionally (cf. BAIRLEIN & HÜPPOP 2004, Crick 2004, Bairlein & WINKEL 2001). Clear relationships between large-scale climatic cycles such as the North Atlantic Oscillation (NAO) and the condition of songbirds caught during spring migration have also been demonstrated (HÜPPOP & HÜPPOP 2003). Climate change can influence the conditions in breeding, resting and wintering areas or the supply of these partial habitats.

Overall, the existing pressures are assessed as medium to high at times.

2.10.2.5 Importance of sites and areas for migratory birds

The areas EN1 to EN13 for offshore wind energy in the North Sea identified in the spatial plan are assessed separately with regard to their importance for bird migration. Due to a lack of knowledge about bird migration in the dismissed areas EN14 to EN19 in the duckbill of the EEZ, no separate assessment is made for these areas.

Analogous to the status assessment of the bird in the EEZ, the assessment of the importance of areas EN1 to EN13 for bird migration is based on the following assessment criteria:

-Large-scale importance of bird migration

-evaluation of the occurrence

-Rarity and vulnerability

For the criterion of existing pollution, please refer to the explanations in Chapter 2.10.2.4

Large-scale significance

No specific migration corridors can be identified for any migratory species in the North Sea EEZ. The bird migration runs in a broad-front migration across the North Sea with a tendency towards coastal orientation. For the areas EN1 to EN13, this does not result in any differences in their large-scale importance for bird migration.

Assessment of the occurrence

In the sea areas where areas **EN1 to EN3 are** located, echoes were detected almost continuously in both migration periods on the basis of entire migration nights or days during the cluster surveys "North of Borkum" (AVITEC RESEARCH 2017) in 2016. The main bird migration events were in spring at the end of March and April and in autumn in October and early November. There were bird migration events of varying strength up to mass migration on a long-term site-specific scale. During the day, 142,764.6 bird movements (121 echoes/(h*km)) were recorded, extrapolated for the entire spring season, and 265,039 bird movements (358 echoes/(h*km)) were recorded at night. In autumn, the corresponding values were extrapolated to 127,648 bird movements; 129 echoes/(h*km) during the day and 203,236 bird movements; 217 echoes/(h*km) at night. A maximum value of 3,535.6 echoes/(h*km) was recorded in spring and 1,830.4 echoes/(h*km) in autumn. Migration intensities averaging over 1,000 echoes/(h*km) were recorded on a total of nine nights in spring 2016; this mark was exceeded once during the day. In autumn, migration intensities averaging over 1,000 echoes/(h*km) were recorded on only four nights.

In the cluster surveys "Nördlich Helgoland" (IBL ET AL. 2017) in the area of site **EN4,** the monthly means of the nocturnal migration rates ranged from 34 echoes/(h*km) in August 2016 to 423 echoes/(h*km) in March 2016. The mean migration rate over the entire period was 224 echoes/(h*km). The highest nocturnal migration rate was reached on the night of 26-27 October 2016 (3,311 echoes/(h*km)). In approx. 39 % (spring) and 67 % (autumn) of the nights, migration rates were below 100 echoes/(h*km). Daytime migration rates were significantly lower, ranging from 38 echoes/(h*km) in August 2016 to 142 echoes/(h*km) in March 2016, with a mean migration rate of 93 echoes/(h*km) over the entire period. In total, nine nights with migration rates of more than 1,000 echoes/(h*km) occurred during the 2016 survey year (eight in spring, one in autumn). This means that the maximum migration rates are of a comparable order of magnitude to those on FINO1 (cluster "North of Borkum").

The measurements within the framework of the cluster monitoring "Westlich Sylt" (BioConsult SH 2017), which also cover the area **EN5,** show that according to the results of the vertical radar, night migration is generally more pronounced than day migration. During the 2016 autumn migration, intensive bird migration was recorded primarily in October and November; as expected, the months of July and August had lower migration intensities. Mass migration days were not recorded during the autumn migration; the maximum migration intensity was 120 echoes/(h*km) and was recorded at the end of October. High migration intensities on the spring migration were recorded mainly in March and April. The maximum value of 400 echoes/(h*km) was clearly above the maximum value of the autumn migration. Bird migration was very irregular, especially at night. Thus, 72.5% of the total migration volume of the spring migration and 52.4% of the autumn migration were recorded on the five nights with the highest number of migrants. High migration rates were only reached on a few days; on most of the recording days there was little bird migration.

The available studies of the cluster monitoring "Cluster 6" from 2015 (Planungsgruppe Umweltplanungen 2017) as well as the studies of the cluster monitoring "Eastern Austerngrund" (IfAÖ et al. 2017) from 2016 cover the areas **EN6** to **8** and are used for the assessment. Since current data for the areas of **EN9** to **13 are** missing, but these are immediately adjacent to the north of areas 6-8, the following statements are transferable.

During the surveys of Cluster 6, the nocturnal bird migration showed strong fluctuations during the recording period (January 2015 to March 2016), with strong bird migration with mean migration rates of more than 1,000 echoes/(h*km) occurring on only one night (18/19.10.2015). In spring, maximum mean migration rates of about 700 echoes/(h*km) were recorded. In approx. 25 % of the nights the migration rate was below 10 echoes/(h*km) and in approx. 52 % of the nights below 50 echoes/(h*km). The mean nocturnal migration rates per month ranged from 14 echoes/(h*km) (July 2015) to 358 echoes/(h*km) in October 2015. For the entire period, the mean migration rate was 146 echoes/(h*km). The maximum hourly values varied between 104 echoes/(h*km) (July 2015) and 2,354 echoes/(h*km) (March 2015). A high difference between mean and median in the monthly values indicates a high dispersion of migration rates, especially in the months of April and October 2015. The seasonal distribution and intensity of daytime migration rates according to vessel records is characterised by a strong fluctuation. The highest migration rates in spring with values between about 300 echoes/(h*km) occurred on two days at the end of March and on one day in early April 2015. In autumn, migration rates of more than 200 echoes/(h*km) were reached on only one day (18.10.2015). The nocturnal migration rates determined by vertical radar as part of the "Eastern Oyster Ground" cluster surveys showed a high variation between the individual nights. The monthly mean values of the nocturnal migration rates ranged from 29 echoes/(h*km) (May 2016) to 361 echoes/(h*km) in October 2016 and reached an average value of 144 echoes/(h*km) over the entire period. Daytime migration rates were lower (mean: 84 echoes/(h*km)) and varied from 27 echoes/(h*km) in April 2016 to 125 echoes/(h*km) in October 2016. Mean nighttime migration rates were higher in spring (162 echoes/(h*km)) than in autumn (131 echoes/(h*km)), but the difference was not statistically significant. The daytime migration rates, on the other hand, differed significantly when comparing the migration periods, with higher migration rates in autumn (105 echoes/(h*km), stronger migration days especially in August and October 2016 than in spring (54 echoes/(h*km).

A rough comparison of the results of the migration intensities for individual areas described above yields roughly comparable results for all areas (**EN1-13**) with regard to the monthly means. Differences can be seen in the maximum values. However, it must be taken into account that there is a large interannual variability.

However, a recent cross-project evaluation of all data from large-scale bird migration monitoring for offshore wind farm projects showed a gradient of decreasing migration intensities with greater distance from the coast for nocturnal bird migration over the North Sea, which is dominated by songbirds (WELCKER 2019a).

Taking into account the high migration rates over the German Bight, the individual areas **EN1** to **EN13 are of** medium importance with regard to the criterion of migration intensity.

Number of species and endangerment status of the species involved

In terms of species numbers and endangerment status, the areas **EN1** to **EN13** do not differ significantly. In the above-mentioned current surveys of 2015 and 2016, between 68 and 81 species were detected annually in the lake areas. Of the species detected, 7-13 are listed in Annex I of the V-RL. The number of species detected is assessed as average and the endangerment status as above average.

Conclusion

Although guidelines and concentration areas are lacking, areas **EN1** to **EN13** have an overall average to above-average importance for bird migration.

2.11 Bats and bat migration

Bats are characterised by a very high mobility. While bats can travel up to 60 km per day in search of food, nesting or summer roosting sites and hibernation areas are located several hundreds of kilometres apart. Migratory movements of bats in search of extensive food sources and suitable resting sites are very often observed on land, but mainly aperiodically. However, migratory movements of bats over the North Sea have been little documented and largely unexplored to date.

2.11.1 Data situation

The data base 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. In the following, reference is made to general literature on bats, findings from systematic surveys on Helgoland as well as acoustic surveys from the FINO1 research platform and other sources of knowledge in order to reflect the current state of knowledge.

2.11.2 Spatial distribution and condition assessment

The migration behaviour of bats is very variable. On the one hand, differences can occur species- and sex-specific. On the other hand, migratory movements can vary greatly even within populations of one species. Based on their migratory behaviour, bats are divided into short-distance, medium-distance and long-distance migratory species.

In search of nesting, feeding and resting sites, bats undertake short- and medium-distance migrations. For medium distances, corridors along flowing waters, around lakes and Bodden waters are known (BACH & MEYER-CORDS 2005). Long-distance migrations, however, are still largely unexplored. Migration routes have hardly been described for bats. This is especially true for migratory movements over the open sea. In contrast to bird migration, which has been documented by extensive studies, the migration of bats remains largely unexplored due to the lack of suitable methods or large-scale special monitoring programmes.

The long-distance migratory species include the greater evening bat (*Nyctalus noctula*), rough-skinned bat (*Pipistrellus nathusii*), two-coloured bat (*Verspertilia murinus)* and lesser evening bat (*Nyctalus leisleri*). For these four species, regular migrations over a distance of 1,500 to 2,000 km have been recorded (TRESS et al. 2004, HUTTERER et al. 2005).

Long-distance migration is also suspected for the species of mosquito bat (*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 found on islands, ships and platforms in the North Sea.

However, based on observations of bats on Helgoland, the number of bats migrating from the Danish coast across the German North Sea in autumn is estimated at about 1,200 individuals (SKIBA 2007). An evaluation of observations of bats migrating from southwest Jutland to the North Sea arrives at the same estimate (SKIBA 2011).

Visual observations, e.g. on the coast or on ships and offshore platforms, provide initial indications, but are hardly suitable for fully recording the migration behaviour of nocturnal and night-migrating bats over the sea. The recording of ultrasonic calls of bats by suitable detectors (so-called "bat detectors") provides good results on the occurrence and migration movements of bats on land (SKIBA 2003). The results obtained so far from the use of bat detectors in the North Sea only provide initial indications. The acoustic surveys of bat migration over the North Sea on the research platform FINO1 resulted in detections of only at least 28 individuals between August 2004 and December 2015 (HÜPPOP & HILL 2016).

When recording bat migration over the open sea, in addition to general occurrence, species composition and migration routes, there is also the question of the heights at which bats migrate in order to be able to assess a possible collision risk with offshore wind farms. The individuals recorded by HÜPPOP & HILL (2016) were recorded between 15 - 26 m at mean sea level, which includes the area between the lower rotor blade tip and the water surface of the majority of wind farms, depending on location and method. BRABANT et al. (2018) surveyed bat occurrence at Thornton Bank wind farm using bat detectors at 17 m and 94 m above sea level. Only 10 % of the total of 98 bat records, and thus significantly less than at 17 m, were recorded at a higher height.

According to Annex IV of the Habitats Directive, all bat species belong to the animal and plant species of Community interest requiring strict protection. Some species, such as the rough-skinned bat and the greater evening bat, are listed in Appendix II of the Convention on the Conservation of Migratory Species (CMS) of 1979, the "Bonn Agreement". A total of 25 bat species are native to Germany. Of these, the current Red List of Mammals (MEINIG et al. 2008) assigns two species to the category "endangerment of unknown extent", four species to the category "critically endangered" and three species to the category "threatened with extinction". The long-winged bat (*Miniopterus schreibersii) is* considered "extinct or lost". Of the species found more frequently in Germany's marine and coastal areas, the common evening bat is on the forewarned list, and the common pipistrelle and rough-skinned bats are considered "endangered". The data available is considered insufficient for an assessment of the endangerment status of the lesser evening bat.

The available data for the North Sea EEZ are fragmentary and insufficient to draw conclusions on bat migration. Based on the available data, it is not possible to gain concrete insights into migrating species, migration directions, migration altitudes, migration corridors and possible concentration areas. Previous findings only confirm that bats, especially long-distance migratory species, fly over the North Sea.

2.12 Biodiversity

Biological diversity (or biodiversity for short) comprises the diversity of habitats and biotic communities, the diversity of species and the genetic diversity within species (Art. 2 Convention on Biological Diversity, 1992). Biodiversity is the focus of public attention. Species diversity is the result of over 3.5 billion years of evolution, a dynamic process of extinction and speciation. 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, in terms of phylogenetic biodiversity the sea is more comprehensive and phylogenetically more highly developed than the land. Of the 33 known animal phyla, 32 are found in the sea, 15 of which are exclusively marine (VON WESTERNHAGEN & Dethlefsen 2003).

Marine diversity eludes direct observation and is therefore difficult to estimate. To estimate it, aids such as nets, fish traps, snares, traps or optical registration methods must be used. However, the use of such gear can only ever provide a section of the actual species spectrum, precisely that which is specific to the gear in question. Since the North Sea, as a relatively shallow marginal sea, is more accessible than, for example, the deep sea, intensive marine and fisheries research has taken place for about 150 years, leading to an increase in knowledge about its fauna and flora. This makes it possible to draw on inventory lists and species catalogues to document possible changes (VON WESTERNHAGEN & DETHLEFSEN 2003). According to the results of the Continuous Plankton Recorder (CPR), about 450 different plankton taxa (phyto- and zooplankton) are currently identified in the North Sea. Of the macrozoobenthos, a total of about 1,500 marine species are known. Of these, an estimated 800 are found in the German North Sea area (RACHOR et al. 1995). According to YANG (1982), the fish fauna of the North Sea is composed of 224 fish and lamprey species. For the German North Sea, 189 species are given (FRICKE et al. 1995). In the North Sea EEZ, 19 species of seabirds and resting birds occur regularly in larger populations. Of these, three species are listed in Annex I of the V-RL.

With regard to the current state of biodiversity in the North Sea, it should be noted that there are countless indications of changes in biodiversity and species assemblages in all systematic and trophic levels of the North Sea. The 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 control and warning function in this context, as they show the status of the populations of species and biotopes in a region. Based on 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 lampreys established in the North Sea (THIEL et al. 2013, FREYHOF 2009) are assigned to a Red List category. The marine mammals form a species group in which all representatives are currently endangered, with the bottlenose dolphin even having already disappeared from the area of the German North Sea (VON NORDHEIM et al. 2003). Of the 19 regularly occurring species of seabirds and resting birds, three are listed in Annex I of the Birds Directive. In general, according to the Birds Directive, all wild native bird species are to be conserved and thus protected.

2.13 Air

Shipping traffic 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 applied to shipping in the North Sea as an emission control area, so-called "Sulphur Emission Control Area" (SECA). According to Annex VI, Regulation 14 of the MARPOL Convention, ships may only use heavy fuel oil with a maximum sulphur content of 0.1%. Worldwide, a limit of 3.5% still applies at present. According to a resolution of the International Maritime Organisation (IMO) in 2016, this limit is to be reduced to 0.5% worldwide from 2020.

Emissions of nitrogen oxides are particularly relevant for the North Sea as an additional nutrient load. In this regard, the IMO decided in 2017 that the North Sea will be declared a "Nitrogen Emission Control Area" (NECA) from 2021. The reduction in the discharge of nitrogen oxides into the Baltic Sea region through the North Sea and Baltic Sea ECA measure is estimated at 22,000 t in total (European Monitoring and Evaluation Programme (EMEP 2016)).

2.14 Climate

The German North Sea lies in the temperate climate zone. Warm Atlantic water from the North Atlantic Current is an important influencing factor. Icing can occur in the coastal area, 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 the current report of the Intergovernmental Panel on Climate Change ((IPCC, 2019)), large-scale impacts of climate change on the oceans are expected to include in particular an increase in sea surface temperature, further acidification and a decline in oxygen. Sea levels continue to rise at an increasing rate. Many marine ecosystems react sensitively to climate change.

Global warming is also expected to have a considerable influence on the North Sea, both through a rise in sea level and through changes in the ecosystem. In recent years, for example, species that were previously only found further south are spreading, and the habits of long-established species are changing, in some cases significantly.

2.15 Landscape

The marine landscape visible above the water column today is characterised by large-scale open space structures surrounded by offshore wind turbines. In the future, the landscape will continue to change due to the expansion of offshore wind energy, and the required lighting may also have a visual impact on the landscape.

In addition to offshore wind farms, there are platforms and measuring masts for research purposes in the plan area, which are located within or in the immediate vicinity of the wind farms. In addition, the A6-A production platform is currently located in the Duck's Bill area (hydrocarbon extraction).

The degree to which the landscape is affected by vertical structures is strongly dependent on the respective visibility conditions.

The space in which a building becomes visible in the landscape is the visual impact space.

It is defined by the visual relationship between the structure and its surroundings, whereby the intensity of an effect decreases with increasing distance (GASSNER et al. 2005).

For platforms and offshore wind farms planned at a distance of at least 30 km from the coastline, the impact on the landscape as perceived from land is not very high. At such a distance, the platforms and wind farms will not be very massively perceptible even in good visibility conditions. This also applies with regard to night-time security lighting.

2.16 Cultural and other material assets (underwater cultural heritage)

2.16.1 Recording of the underwater cultural heritage as a protected asset and data situation on underwater cultural heritage in the EEZ

Known underwater cultural heritage in the coastal sea and to some extent in the EEZ is recorded in the registers of sites and monuments of the northern German coastal states. However, it is important to note that this only applies to a small part of the underwater cultural heritage. The cultural authorities of the federal states are only responsible for state waters. Therefore, a systematic processing of information on the underwater cultural heritage in the EEZ has largely been omitted. The quality of the data also varies, for example from identified historical wrecks to site-specific information from records, and may need to be improved for a concrete planning statement. The registers of sites and monuments therefore reflect the respective state of knowledge, but not the real stock of underwater cultural heritage.

An active survey of underwater obstacles - and thus also shipwrecks - in the North German coastal sea is only carried out by the Federal Maritime and Hydrographic Agency (BSH). However, this wreck search does not focus on underwater cultural heritage, but serves to locate and assess obstacles to navigation and therefore concentrates on objects rising from the seabed that could pose a threat to maritime navigation or fisheries. Although the BSH's findings are regularly incorporated into the coastal states' registers of sites and monuments, underwater cultural heritage that is covered by sediment or barely visible on the seabed is not normally recorded in the wreck search.

An impression of the actual density of soil monuments in the coastal sea is provided by maritime construction projects such as submarine cable connections or pipelines, in the course of which a large number of previously unknown soil monuments regularly come to light during preliminary investigations.

The risk of unexpected discovery of soil monuments in the course of a construction project can only be minimised by a qualified inventory as part of the environmental impact assessment.

2.16.2 Potential for prehistoric settlement traces in the German EEZ

Areas of the German EEZ in the North Sea were also land-locked regions in the early Holocene that were settled by humans between about 10,000 and 6,000 years ago (Schmölcke et al. 2006; Behre 2003). In water depths of up to 20 m, preserved palaeolandscape remains in the form of peat and tree remains have been detected so far (Tauber 2014). Archaeological cultural heritage in the form of settlement sites has been explored in water depths of up to 10 m (Hartz et al. 2014). Consequently, in the German EEZ of the North Sea with water depths between 15 m and 50 m, preserved prehistoric settlement traces can be expected in palaeolandscapes. Landscape reconstructions can be used to identify special potential areas for archaeological sites. By evaluating erosion zones, areas with no longer preserved occupation traces can be highlighted.

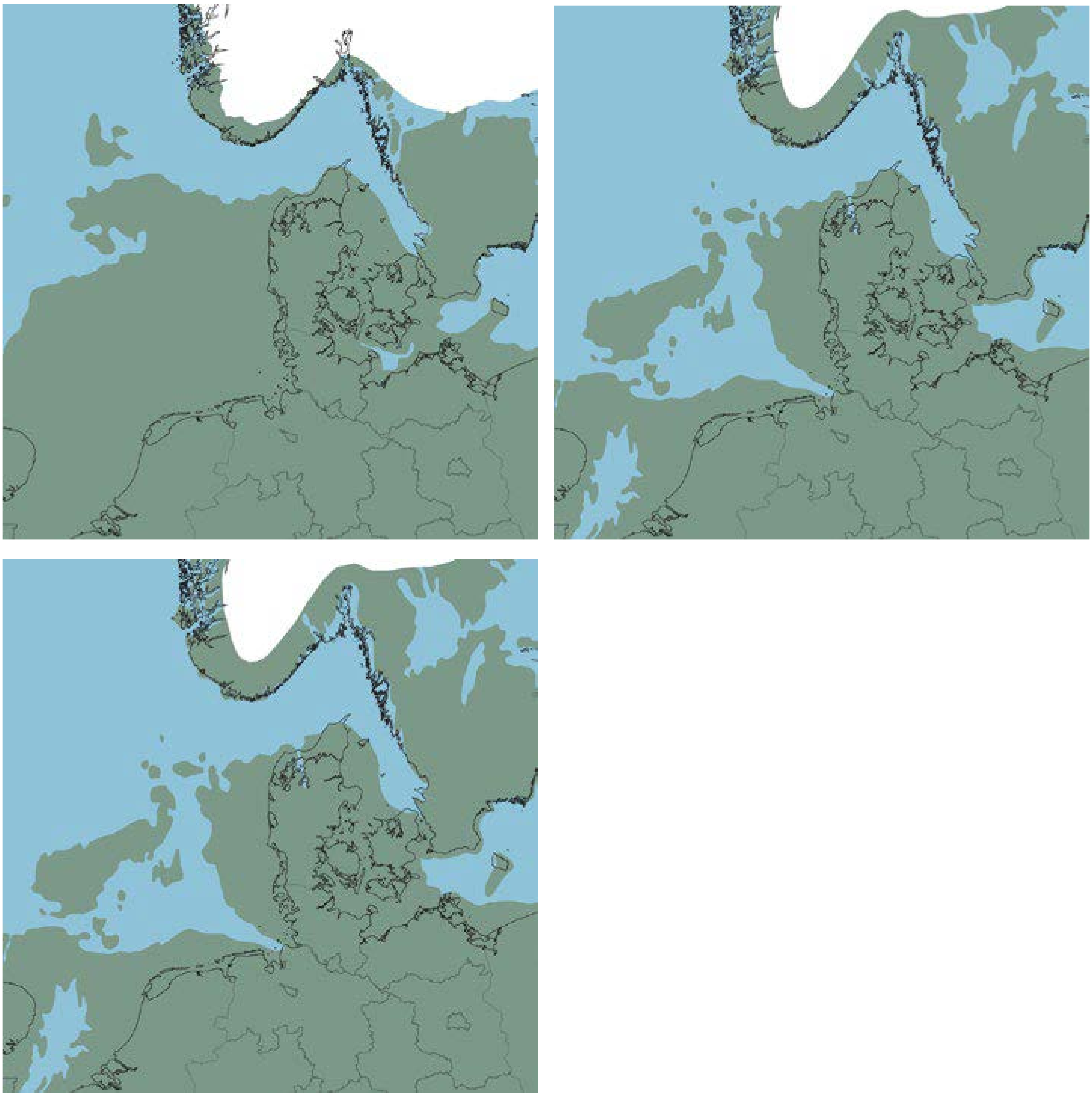


Figure 42: Sea-level rise and landscape changes during the Holocene in northern Europe (from top to bottom: 9700-9200 cal. BC (Preboreal); 8700-8000 cal. (Boreal); 6500-4500 cal. BC (Atlantic). Today's coastlines and the borders of the federal states are highlighted in grey, land is shown in green, seas and lakes are marked in blue and glaciers appear in white (maps compiled by the Centre for Baltic and Scandinavian Archaeology, here taken from the expert contribution on cultural heritage of the heritage protection authorities of the coastal federal states of Lower Saxony, Schleswig-Holstein and Mecklenburg-Western Pomerania).

One example of an area with high potential for the preservation of Stone Age settlement sites is the Ems Urstromtal. Drill cores and reflection seismics were used to reconstruct the subsurface of the North Sea basin and trace the glacial valley of the Ems, which flowed into the Elbe glacial river (HEPP et al. 2017, HEPP et al. 2019). River valleys formed important settlement areas in the Mesolithic for populations oriented towards hunting and fishing. Of particular importance is the finding that the original flow of the

Ems changed from fresh to brackish water in the course of 200 years, which corresponds to a rapid sea-level rise of about 2.5 m per year (HEPP et al. 2019, 591). Due to the rapid flooding and sedimentation, it is possible that not only individual finds, but entire sites with closed find contexts have been preserved here at the bottom of the North Sea.

With a total area of 18,700 km2 , the Dogger Bank is the largest sandbank in the North Sea, extending into the "duck's bill" of the German EEZ. While the North Sea has an average depth of 94 m, the Dogger Bank is only 30 m deep on average. On the basis of individual finds, settlement from the so-called Doggerland in the area of the Dogger Bank can be proven from the early Mesolithic onwards. (BALLIN, 2017)(BAILEY et al. 2020, 190 ff.). A special potential for the preservation of archaeological sites is given by a natural event that took place when the Dogger Bank was still terrestrial and settled: settlements could be preserved as a closed find context under a massive sediment layer that was deposited here by a flood wave triggered by the Storegga landslide in Norway around 6225-6170 BC (BONDEVIK et al. 2012; FLEMMING 2004, 26).

2.16.3 Wrecks of watercraft and wreckage

This genre of underwater cultural heritage includes not only the wrecks of watercraft but also wreck parts and associated equipment, cargoes and inventories. The majority of known wreck sites are boats and ships of various ages. The spectrum ranges from Stone Age dugouts to wooden trading vessels of the Middle Ages and warships from the World Wars.

Seaworthy watercraft are archaeologically attested for the North Sea area from the Bronze Age onwards. These include several boats from Britain, of which the Dover Boat of c. 1575-1520 BC is probably the best known (Clark 2004).

From the Middle Ages onwards, the sea routes of the long-distance traders ran across the open sea, as the 12th chapter of the Hanseatic Sea Book in the "House Sea" of the Hanseatic League shows. Although ship finds from this period have so far tended to be found in the immediate coastal area and in silted-up former harbour areas, more and more new finds are being made in the open sea. For example, during the salvage of containers in the North Sea in 2019, a merchant ship from 1536 with a cargo of copper ingots was discovered by chance (van Ommeren 2019).

Shipping in the North and Baltic Seas of the 16th-18th centuries is characterised above all by the strengthening of the United Netherlands as a trading power and the naval wars of the Scandinavian kingdoms for supremacy over the Baltic Sea. Examples include the Swedish flagship "Princessan Hedvig Sophia", which sank in 1715, the frigate "Mynden", which sank off Rügen in 1718, and the Danish Orlog ship "Lindormen" of 1644 (Auer 2004; Auer 2010; Segschneider 2014).

In the course of the 18th and 19th centuries, enormous increases in the volume of trade across the North and Baltic Seas can be recorded. Examples of this are coal exports from the British Isles and timber exports from the Baltic. These goods were transported on wooden sailing ships and later on iron steamships. The brisk maritime trade also led to an increase in shipping accidents during this period. Archaeologically investigated ship finds from this period include the wreck of the British merchant ship "General Carleton" from 1785 (Ossowski, 2008), and the wreck of a 19th century coal transporter off Rotterdam (Adams et al., 1990).

With the emergence of industrial composite aircraft wrecks and iron or steel shipbuilding from the mid-19th century onwards, the knowledge gained from written and pictorial sources predominates. Due to their often better preservation, wrecks from the 19th and 20th centuries are currently far more present in the archaeological record than wooden wrecks (Oppelt 2019). In the longer term, however, this is likely to change due to the progressive corrosion of steel wrecks.

Due to their historical significance and the partial lack of written sources on certain military and war-related aspects, wrecks from the two World Wars up to and including 1945 are listed as archaeological cultural monuments. They also have an important function as places of remembrance (Ickerodt 2014). Particularly in the course of the First World War, naval battles also resulted in the loss of several vehicles in a limited space. For example, three small cruisers and one torpedo boat sank during a naval battle between the Imperial German and British navies west of Helgoland in August 1914, the wrecks of which are all located in the German EEZ (Huber & Witt 2018).

Equipment or parts of cargo can provide evidence of maritime activities in the past. Among the most common objects are anchors that, for various reasons, could not be recovered after an anchoring manoeuvre and remained on the seabed.

So-called ballast piles, accumulations of stone ballast on the bottom, were formed, for example, when ships were loaded off a natural harbour, but can also be an indication of the lightering of a ship that has run aground. However, it is not uncommon for ballast material to conceal a shipwreck.

2.16.4 Aircraft wrecks and rockets

Most of the known findings of aircraft wrecks in the North Sea and Baltic Sea are related to the Second World War. The fates of countless aircraft crews, both on the Allied and the German side, are unknown. Aircraft crashes can rarely be precisely located, making it difficult to classify the wrecks. While ditchings can result in relatively well-preserved aircraft wrecks, crash sites are often characterised by extensive fields of debris on the bottom of the water. In addition to providing insights into technical aspects of construction and deployment, the aircraft wrecks of World War II also bear eloquent witness to the events of the war.

Another aspect is the possible presence of human remains. Wrecks from the last two wars in particular are often not only ground monuments but also war graves.

Although prehistoric and early historic wrecks were mostly discovered in coastal waters or come from burial sites, under favourable conditions they could also be present in the German EEZ. At the latest, medieval shipwrecks are known from the high Baltic Sea from depths of more than -50 metres. There, the wooden wrecks are particularly well preserved thanks to the low temperatures and the low infestation by wood-decomposing organisms.

In general, wooden ships or their remains may have survived undiscovered under sediment layers. Even in the case of wreckage that is barely visible above ground, considerable remains of a ship's hull together with the ship's inventory may lie hidden under the sediment. Cargo residues and parts of the equipment or armament are thus in a closed find context and allow unique insights into the past like "time capsules".

2.16.5 Potential for wrecks in the German EEZ

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2.16.6 Status assessment of the underwater cultural heritage property

Central factors for the definition of an archaeological monument (ground monument or monument under water) are its cultural-historical significance (monument eligibility) and the public interest in its exploration and preservation (monument worthiness).

The assessment of the significance of the protected property or its monument value is carried out according to the following criteria (see also the monument protection laws of the federal states; see also Ickerodt 2014):

- Historical testimonial value
- Scientific or technical value, research value
- Social significance (place of remembrance, e.g. sepulchre)
- Rarity value
- Integrity (degree of preservation, condition, threat)

The testimonial value varies depending on the preservation and type of site. For example, the historical testimonial value of underwater sites is generally very high due to the very good preservation conditions for organic materials. In the land area, Middle Stone Age sites are mostly limited to scattered flint objects. Only through the preservation of bones, antlers, wood and other plant remains in boggy and submerged sites can the way of life, the settlement structure or the social organisation of the people of that time be researched further. The same applies to finds of organic materials from well-preserved shipwrecks, which may belong to personal equipment, cargo or armament, for example. Well-preserved wrecks with preserved inventory and construction elements have a high testimonial value.

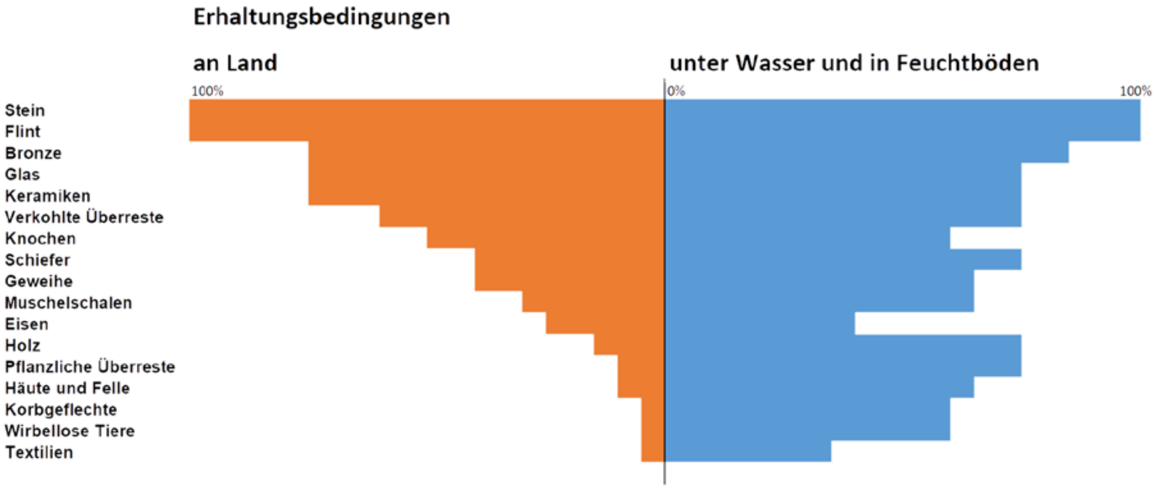


Figure 43: Comparison of the preservation conditions of archaeological finds on land and under water (after Coles 1988).

The technical value can be seen in the example of watercraft. These were among the most advanced means of transport of their time and reflect the technological know-how of a society. Merchant ships were built to transport cargo safely over long distances. Warships were not only intended to serve as effective combat platforms, but also had to meet high standards of seaworthiness, manoeuvrability and speed, and also had a representative function. Therefore, the scientific, technical and testimonial value of shipwrecks with well-preserved construction elements is high.

Since the loss of a vehicle with cargo and inventory captures a specific moment in the past, wrecks are often referred to as "time capsules". If properly preserved, an analysis of the wreck find offers detailed insights into everyday life on board. In addition to technological progress, it is therefore often possible to draw conclusions from ship finds about political, economic and landscape-typical factors as well as the social structure of a society. This illustrates the extraordinary research value of underwater sites and also their special integrity compared to sites on land.

The social commemorative value is considered to be particularly high in the case of the shipwrecks and aircraft wrecks of the First and Second World Wars.

The rarity value varies depending on the type and dating of the site. Prehistoric wrecks have a very high rarity value. The same applies to medieval and early modern wreck finds with good preservation. Modern wreck finds can also have a high rarity value if they are distinguished by special technical features or construction characteristics.

The integrity or state of preservation of an underwater site must be determined and assessed individually. Both the conditions of deposition during the genesis of a site or the sinking and emplacement of a wreck as well as later destruction, for example by abiotic factors such as erosion by currents or decomposition by organisms, influence the completeness and preservation of a site or parts of a site. As already mentioned, the preservation conditions for organic materials under oxygen exclusion in the underwater environment are particularly outstanding. While exposed wrecks are subject to erosion and may be damaged by various uses on the seabed, fully covered sites offer excellent preservation conditions.

2.17 Human beings as a protected resource, including human health

Overall, the planning area defined in the ROP has a low significance for the human resource.

Marine space is the working environment for people employed on ships and fixed installations in the sea, in maritime shipping, fisheries, the offshore wind industry, resource extraction, scientific research and defence.

Exact figures on the number of people regularly staying in the area are not available.

The importance as a working environment can be considered rather low. Occupational health and safety is subject to the respective specialist legislation, for shipping, for example, international maritime law as well as national regulations; for offshore wind energy, protection and safety concepts are drawn up as part of the approval procedures. On the other hand, the sea is a recreational and leisure space for people who use the marine space, on ferries and cruise ships, but also with pleasure boats and tourist watercraft.

Direct use for recreation and leisure by recreational boats and tourist watercraft in the North Sea is rare.

Further impacts on humans or their living environment due to activities at sea, e.g. as a result of shipwrecks, may occur beyond the planning area, especially on the islands and coasts.

Since the EEZ of the North Sea is of only minor importance for active recreational use and as a working environment, the existing impacts can be described as low. No special significance of the planning area for human health and well-being can be derived.

2.18 Interactions between the protected goods

The components of the marine ecosystem, from bacteria and plankton to marine mammals and birds, influence each other through complex processes. The biological assets plankton, benthos, fish, marine mammals and birds described individually in Chapter 2interdependent within the marine food chains.

Phytoplankton serves as a food source for organisms that specialise in filtering the water for food. The most important primary consumers of phytoplankton include zooplanktic organisms such as copepods and water fleas. Zooplankton has a central role in the marine ecosystem as a primary consumer of phytoplankton on the one hand and as the lowest secondary producer within marine food chains on the other. Zooplankton serve as food for the secondary consumers of the marine food chains, from carnivorous zooplankton species to benthos, fish to marine mammals and seabirds. Among the top components of marine food chains are the so-called predators. Upper predators within marine food chains include aquatic and seabirds and marine mammals. In food chains, producers and consumers are interdependent and influence each other in many ways.

In general, food availability regulates the growth and distribution of species. Depletion of the producer results in the decline of the consumer. Consumers, in turn, control the growth of producers by eating away at them. Food limitation affects the individual level by impairing the condition of the individual. At the 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 timed succession or sequencing of growth between the different components of marine food chains is critical. For example, the growth of fish larvae is directly dependent on the available biomass of plankton. For seabirds, breeding success is also directly related to the availability of suitable fish (species, length, biomass, energetic value). Temporally or spatially offset occurrence of succession and abundance of species from different trophic levels leads to disruption of food chains. Temporal offset, the so-called trophic "mismatch", causes early developmental stages of organisms in particular to become undernourished or even starve to death. Disruptions in marine food chains can affect not only individuals but also populations. Predator-prey relationships or 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 of cod stocks in the Baltic Sea had a positive effect on the development of sprat stocks (ÖSTERBLOM et al. 2006).

Trophic relationships and interactions between plankton, benthos, fish, marine mammals and seabirds are controlled by multiple control mechanisms. Such mechanisms operate from the bottom of food chains, starting with nutrient, oxygen or light availability, upwards to upper predators. Such a bottom-up control mechanism may act by increasing or decreasing primary production. Effects emanating from the upper predators downwards, via so-called "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, front formation, water stratification and currents play a crucial role in food availability (increasing primary production) and utilisation by upper predators. Exceptional events such as storms and ice winters also influence trophic relationships within marine food chains. Biotic factors such as toxic algal blooms, parasite infestations and epidemics also affect the entire food chain.

Anthropogenic activities also have a decisive influence on the interactions within the components of the marine ecosystem. Humans affect the marine food chain both directly through the capture of marine animals and indirectly through activities that can influence components of the food chains.

Overfishing of fish stocks, for example, confronts upper predators such as seabirds and marine mammals with food limitations or forces them to find new food resources. Overfishing can also cause changes in the lower part of the food chain. For example, jellyfish can become extremely widespread when their fish predators are fished away. Furthermore, shipping and mariculture are additional factors that can lead to positive or negative changes in marine food chains through the introduction of non-native species. Discharges of nutrients and pollutants via rivers and the atmosphere also influence marine organisms and can lead to changes in trophic conditions.

Natural or anthropogenic impacts on one of the components of the marine food chains, e.g. the species spectrum or the biomass of the plankton, can influence 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 goods.

The complex interactions between the various components ultimately result in changes in the entire marine ecosystem of the North Sea. From the changes already described in Chapter 2relation to the protected goods, it can be summarised for the marine ecosystem of the North Sea:

- Since the early 1980s, there have been slow changes in the living marine environment.
- Since 1987/88, rapid changes in the living marine environment have been observed.

The following aspects or changes can influence the interactions between the different components of the living marine environment: Change in species composition (phyto- and zooplankton, benthos, fish), introduction and partial establishment of non-indigenous species (phyto- and zooplankton, benthos, fish), change in abundance and dominance ratios (phyto- and zooplankton), change in available biomass (phytoplankton), prolongation of growth phase (phytoplankton, copepods), Delay of growth phase after warm winter (spring diatom bloom), food organisms of fish larvae have advanced growth onset (copepods), decline of many area-typical species (plankton, benthos, fish), decline of food base for upper predators (seabirds), shift of stocks from southern to northern latitudes (cod), shift of stocks from northern to southern latitudes (harbour porpoise).

3 Expected development in the event of non-implementation of the plan

According to Annex 1 No. 2b) to Section 8 ROG, a forecast of the development of the state of the environment must be included in the environmental report even if the planning is not carried out.

3.1 Shipping

Alongside fishing, shipping is one of the traditional uses of the sea. Several shipping routes run through the territorial sea and the EEZ and are of great importance for German foreign trade and international transit traffic due to their central location in the North Sea and Baltic Sea.

Prior to the adoption of the maritime spatial plans in 2009 and the associated designation of priority and reserved areas for shipping, only traffic separation zones (VTGs) had been established in the North Sea by the International Maritime Organisation (IMO) to ensure ship safety and minimise collision hazards.

In particular, with the emergence of the first offshore wind turbines and the increasing number of applications from the wind energy industry, the need to secure obstacle-free shipping routes and thus the added value of the specifications in the marine spatial planning became clear.

The legal situation of shipping is strongly influenced by international regulations. Particular mention should be made here of the Act on the United Nations Convention on the Law of the Sea of 10 December 1982 (Convention on the Law of the Sea Treaty Act), in which freedom of navigation is guaranteed under Article 58. In addition, internationally applicable rules and standards are laid down by the IMO. For spatial planning, the definition of traffic separation zones is of particular importance here. At potential danger points, they stipulate binding routing in one-way traffic with separate lanes.

The Act on the Tasks of the Federation in the Field of Maritime Navigation (Seeaufgabengesetz - SeeAufgG) and in particular the various ordinances issued on the basis of this Act form the legal basis for measures to avert dangers to the safety and ease of traffic and for the prevention of dangers arising from maritime navigation, including harmful effects on the environment.

Important international conventions on environmental protection in maritime transport are the Convention for the Prevention of Pollution from Ships, as amended by the Protocol of 1978 (MARPOL 73/78), which includes regulations on the discharge of sewage and ship-generated waste, and on the phased reduction of air pollutant emissions.

As the North Sea and the Baltic Sea are SOx emission control areas (SECA), the limit values for sulphur emissions are particularly low here. From 2021, the North Sea and the Baltic Sea will also become NOx emission control areas (NECAs).

The International Convention for the Control and Management of Ships' Ballast Water and Sediments is an international agreement adopted in 2004 within the framework of the International Maritime Organization. The aim of the Convention is to mitigate the damage caused by ballast water to the marine environment, in particular to prevent the introduction of non-indigenous species.

The OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic (1992) and North East Atlantic Environmental Strategy (2010) include measures on the 'clean ship approach', air pollution (e.g. NOx, SOx), ship noise, the introduction and spread of non-indigenous species and other measures to prevent, prevent and combat pollution from ships.

Development of shipping

The average traffic density resulting from the analysis of AIS data shows an increasing demand for space, not least driven by construction, maintenance and supply trips for the growing offshore wind industry, the increasing number of cruise ships and a higher demand for anchor and roadstead space.

In its 2030 maritime transport forecast, the Federal Ministry of Transport and Digital Infrastructure (BMVI) published the forecast development of the handling volume of German seaports (BMVI, 2014). For the period 2010 to 2030, an increase in the transhipment volume from 438 million tonnes to 712 million tonnes is forecast. This involves transshipments from German and foreign ports and their hinterland traffic that use German transport infrastructure. The main drivers for the forecast increase in transhipment volume are the overall continuing trend towards globalisation and the strong export orientation of the German economy. However, this assumed increase in transhipment and shipping traffic as a whole is subject to uncertainties and may be significantly lower due to a changed economic situation and crises.

With regard to the technical development of ships, regulations by the IMO in particular are strong drivers. For example, various cleaning systems or alternative fuels are used to comply with the emission limits for NOx and SOx. The IMO strategy to reduce CO_2 emissions, adopted in April 2018, will also require alternative fuels and increased energy efficiency (DNV GL 2019).

Impacts on the marine environment from shipping

Shipping has various impacts on the marine environment. These include illegal oil disposal at sea, propulsion-related emissions, waste disposal, noise emissions, the consequences of shipwrecks, inputs of toxic substances such as TBT, and the introduction of exotic species. The impacts can be of a supraregional, temporary or permanent nature. These can be summarised as follows:

- supra-regional, temporary impact due to oil input, emissions and input of toxic substances;
- transregional, permanent effect due to the introduction of exotic species.

The following table provides an overview of the impacts caused by shipping and their potential effects on the protected goods. The impacts are predominantly classified as existing impacts (Chapter 2) and as impacts that will occur even if the plan is not implemented.

Table 18: Potential impacts from shipping

Use	Effect	Potential impact	Protected goods																
			Benthos	Fish	Seabirds and resting	Migratory birds	Marine mammals	Bats	Plankton	Biotope types	Biodiversity	Floor	Area	Water	Air	Climate	Man/ Health	Cultural and material	Landscape
Ship-ping	Underwater sound	Impairment / scare effect		x			x												
	Emissions and dis-charges of hazardous substances (accidents)	Impairment/ Damage	x	x	x		x		x	x	x	x		x			x		
	Physical dis-turbance during an-choring	Impact on the se-abed	x t							x t		x t	x t					x	
	Emission of air pollutants	Impairment of air quality			x	x									x	x	x		
	Introduction and spread of invasive species	Change in species composition	x	x	x				x		x								
	Dumping of waste/ discharges	Impairment/ Damage	x	x	x		x		x	x				x			x		
	Collision risk	Collision			x	x	x												
	Visual rest-lessness	Impairment/ scare effect		x	x														

3.1.1 Floor

The seabed is affected by the following impacts of shipping:

Input of pollutants:

Shipping emits operational pollutants that con-tribute to sediment and water pollution. The dis-charge of oil contaminates water and sediment to varying degrees with partly toxic pollutants. Depending on the amount, type and composi-tion, oil slicks or carpets can form, which can be spread over a wide area under appropriate weather conditions and sink to the seabed.

Physical disturbance during anchoring:

When ships anchor, the anchors penetrate the seabed and mix the sediments. This results in a local and temporary influence on the sediment structure.

The above-mentioned impacts occur inde-pendently of the non-implementation or imple-mentation of the plan.

3.1.2 Benthos and biotope types

The following remarks are limited to the impacts of the uses on benthic communities. Since bio-topes are the habitats of a regularly recurring community of species, impairments of the bio-topes have direct effects on the biotic communi-ties.

The impact of shipping on the benthos is caused by the following factors.

- Oil input. Even the smallest oil spills pose a threat to living organisms. The effects of chronic oil pollution on birds are well documented. In contrast, there are only a few studies that examine the effects of chronic oil pollution on other organisms. The few studies show, among other things, a reduced species diversity and number of individuals in molluscs. Bernem (2003) looks primarily at the effects on coastal areas and identifies salt marshes in particular as endangered habitats. Studies of the effects on the benthos of deeper marine areas such as the EEZ are not known, although oil can drift below the water surface and sink to the bottom.
- Input of toxic substances. Since the beginning of the 1970s, effects of TBT on aquatic organisms, which should not actually be affected by the biocidal effect of the chemical, have been known primarily in coastal waters. TBT was shown to be endocrine disrupting, i.e. it interferes with the hormone system of organisms. TBT is capable of inducing a pathomorphosis called imposex not only in mussels but also in separately sexed anterior gastropods. Imposex describes a masculinisation of female animals in snail populations. In the female whelk (Buccinum undatum), an additional formation of male sex organs occurs. Proliferating male genitalia lead to sterilisation and often death of the affected females in the final stage of imposex development in most species (Watermann et al., 2003). Ultimately, entire populations can become extinct (Weigel, 2003). This ultimately led to a far-reaching international ban on organotin antifouling agents in 2008.
- Physical disturbance during anchoring. When ships anchor, there is local and temporary disturbance of the seabed and thus small-scale disturbance of benthic communities.
- Introduction of non-native species. Since 1970, an increasing tendency of first findings of non-indigenous species can be observed. In addition to aquaculture, which in part deliberately uses alien species, ship traffic via ballast water, the sediments of ballast tanks and the outer walls of ships has contributed to this (Gollasch, 2003). The spectrum of introduced species ranges from macroalgae to invertebrates. If the alien species find optimal living conditions, mass reproduction can occur, which in turn can cause high ecological and economic damage. However, none of the newly introduced species has led to drastic negative impacts in recent years. The species that cause the greatest negative economic impacts, such as the Chinese mitten crab (Eriocheir sinensis) and the shipworm (Teredo navalis), which has now caused considerable damage since it became firmly established, or various phytoplankton species, have been with us for a long time (Gollasch, 2003).The Ballast Water Convention has been in force since 2017 and regulates the introduction and spread of organisms with the ballast water of seagoing ships. The current ballast water exchange in the North Sea is only possible under certain conditions. Species are released with biofouling, but these are sessile species that require suitable environmental conditions (hard substrates) to settle and establish when released. The introduction of alien species through the fouling of ships, including smaller recreational boats, is also increasingly coming into focus.

In summary, the main impacts of shipping on the marine benthos are as follows:

- Supraregional, temporary impact due to oil input, emissions and input of toxic substances, anchorages
- supra-regional, permanent effect due to the introduction of non-native species.

The above-mentioned impacts on benthic communities and biotope types occur independently of the non-implementation or implementation of the plan.

3.1.3 Fish

The effects of shipping on fish fauna include underwater noise, the discharge of hazardous substances, the introduction of waste, and the introduction and spread of invasive species.

Most ships, especially the larger ones, emit mostly low-frequency **underwater sound, which depends,** among other things, on the type of ship, the ship's propeller and the hull design (POPPER & HAWKINS 2019). The sound produced by ships could have an impact on fish fauna. The hearing ability of fish varies greatly. Some species, such as herring, have very good hearing because their inner ear is connected to the swim bladder. When sound hits the swim bladder, the vibrations generated are mechanically transmitted to the ear. This means that herring are probably more sensitive to underwater sound than fish species without a swim bladder, such as flatfish or sand eels. Hearing allows fish, for example, to locate prey, escape predators or find a reproductive partner (POPPER & HAWKINS 2019). The noise could particularly affect fish that communicate using self-produced sounds (LADICH 2013, POPPER & HAWKINS 2019). The continuous underwater sound could mask communication, especially during spawning (DE JONG et al. 2020). Some fish species, such as herring or cod, also showed typical avoidance responses to ship traffic, such as change in swimming direction, increased diving or horizontal movements (MITSON 1995, SIMMONDS & MACLENNAN 2005). In general, fish responses to direct and indirect impacts of shipping are not consistent (POPPER AND HASTINGS 2009) and can vary species-specifically. Even the response of a single species to vessel noise may change depending on its life stage (DE ROBERTIS & HANDEGARD 2013). There is evidence in the literature of possible behavioural changes due to ship noise, but the results are not robust to draw conclusions about significance. Scientific reviews of the existing literature on possible effects of ship noise on fish clearly point to the lack of comparability, transferability and reproducibility of results (POPPER & HAWKINS 2019). Furthermore, long-term studies on the effects of continuous noise emissions on fish in their natural habitat are needed to draw conclusions at the population level (WEILGART 2018, DE JONG et al. 2020).

In addition to acoustic stimuli, the input of pollutants as an effect of shipping traffic should be mentioned in particular. Shipping can have a strong impact on the marine environment as a result of accidents and the potential leakage of pollutants, including **heavy fuel oil in particular.** Several factors, such as the type, condition and quantity of oil, determine the degree of impairment (VAN BERNEM 2003).

It is possible that species with a pelagic lifestyle are able to avoid oil-polluted areas, as has been observed in laboratory studies on salmon (VAN BERNEM 2003). Bottom-dwelling fish species can be harmed by prolonged contact with oily sediments. Possible consequences are the uptake of hydrocarbons from the sediment, the occurrence of certain diseases (including fin rot) and the decline of stocks. Scientific findings from the natural habitat that could be used for a significance assessment are not known.

Fish eggs and juveniles are generally more vulnerable than adults because sensory abilities are not yet or not fully developed and they are less mobile.

Another impact of shipping is the **introduction of non-native species**. Since 1970, an increasing trend of first detections of alien species has been observed. Shipping traffic via ballast water and the outer walls of ships has also contributed to this (GOLLASCH 2003). In principle, non-native fish species can be introduced into the North Sea and potentially become established (GOLLASCH 2002). If the alien species find suitable living conditions, mass reproduction can occur, which in turn can lead to the displacement of native species due to competition for food and habitats. Studies on alien species focus mainly on benthic invertebrates (see BMU 2018). Fish could be spread mainly through the transport of eggs and larvae in ballast water (LLUR 2014). The introduction of alien fish species with invasive potential by shipping is not known in the German North Sea EEZ.

Marine pollution is a global threat to the marine ecosystem and can also have negative impacts in the North Sea. At 85%, plastic is the dominant category of waste on the seabed of the North Sea (THÜNEN 2020). An estimated 600,000 m³ of plastic waste is found in the North Sea (FEDERAL GOVERNMENT 2020), of which about one third is attributable to shipping and fishing (BFN 2017). In addition, they can ingest plastic with their food and spread it through the food web. There are currently no systematic studies on the impacts of plastic on fish fauna that would allow a differentiated assessment. The Thünen Institute for Fisheries Ecology is working on the PlasM project on the risk posed by plastic in the marine environment, which is expected to run until 2021.

The above-mentioned impacts of navigation on fish fauna occur independently of the non-implementation or implementation of the plan.

3.1.4 Marine mammals

Impacts of shipping on marine mammals can be caused by, among other things: Noise emissions, pollution during normal operation or in the event of accidents involving ships. During normal operation, shipping poses a potential threat to marine mammals. The impacts are of low, medium or even high intensity depending on the area. Impacts are also site-specific and temporary or recurrent, e.g. along busy shipping routes.

Direct disturbance of marine mammals by sound emissions is expected to be more frequent, especially along busy traffic separation areas, e.g. north of the East Frisian Islands. Unlike other cetacean species, harbour porpoises are not known to be attracted by ships. In general, harbour porpoises are rather shy. Collisions with ships are also not known for harbour porpoises and seals.

In recent years, numerous studies have been conducted to investigate impacts due to ship noise. The measurement, modelling and characterisation of sound emitted by ships in marine areas with different abiotic environmental parameters has produced valuable findings (ARVESON & VENDITIS, 2000, WALES ET AL., 2002, HATCH ET AL, 2008, DEROBERTIS ET AL, 2013, MCKENNA ET AL, 2013, MERCHANT ET AL, 2014, WITTEKIND, 2014, RUDD ET AL, 2015, GARRETT ET AL, 2016, GASSMANN ET AL, 2017, HERMANNSEN ET AL, 2014, HERMANNSEN ET AL, 2017, KINDA ET AL, 2017). In a recent study, the strongly pronounced differences of up to 30 dB broadband levels for ships of the same class and under comparable operating conditions, were analysed in the context of the now numerous published results. It was found that parameters such as speed over the seabed, width of the vessel and class, as well as the distance of the measuring hydrophone from the vessel and the surface reflection have a great influence on the results. Although it is assumed in the studies that a reduction in sound input can be accompanied by a reduction in speed, it became clear that standardisation in measurement and evaluation is necessary in order to be able to draw correct conclusions in the context of environmental assessments (Chion et al., 2019).

Standardisation of the measurement of sound emitted by ships in deep waters took place in 2017 (ISO 17208-:2016, ISO 17208-2:2019).

A majority of international studies also focused on the effects of sound emitted by ships on marine mammals (whales, seals) or on fish and invertebrate species (Cosens et al., 1993, Erbe 2000, 2003, Kraus et la., 2005, Clark et al., 2009, Götz et al., 2009, Huntigton, 2009, Castellote et al., 2012, Hatch et al, 2012, Erbe et al, 2012, Roland et al, 2012, Anderwalt et al, 2013, Williams et al, 2014, Blundell et al 2015, Dyndo et al 2015, Finneran 2015, Culloch et al., 2016, Ellisson et al, 2016, Pine et al, 2016, Chen et al, 2017, Halliday et al, 2017, Frankel & Gabriele, 2017, Wisniewska et al, 2018, Mikkelsen et al, 2019). Many of these studies suggest that interference may occur through masking of communication, particularly in bearded whales that echo and communicate in low frequency ranges, overlapping with ship sounds. Evidence is found in numerous studies, but their results are often not comparable with each other, transferable and reproducible (Erbe et al., 2019). The potential effects of disturbance from ship noise are also difficult to quantify and differentiate from other sources of disturbance. Furthermore, marine mammals have evolved adaptive mechanisms to maintain communication in noisy environments. Among the known adaptations of cetaceans to the acoustic environment in the oceans is the so-called Lombard effect. The Lombard effect is described as the ability to ensure communication between conspecifics by changing the volume, vocalisation rate and frequency even in noisy environments and has been demonstrated in various animal groups. Cetaceans, such as the harbour porpoise, are also able to increase the volume and frequency of vocalisation as well as change the frequency spectrum. This adaptation is a survival strategy to effectively and efficiently forage for food, escape predators, maintain mother-calf contact, but also seek out conspecifics (Erbe et al., 2019).

The assessment of the impact of underwater sound, including sound emitted by ships, is the subject of several studies (Azzellino et al, 2012, Southall et al, 2009, Dekeling et al, 2014, Gomez et al, 2016, Southall et al, 2019). In the North Sea, further knowledge was gained from 2016 to 2020 as part of the EU research project JOMOPANS (Joint Monitoring and Assessment Programme for the North Sea), taking into account the results from the EU project BIAS (Baltic Sea acoustic Soundscape). The regular assessments of OSPAR and HELCOM also use the current findings. Finally, within the framework of the implementation of the MSFD, the TG-Noise expert group of the EU Commission is concerned with the development of standardised methods and criteria for the assessment of continuous underwater noise with a focus on noise emitted by ships and taking into account the current state of knowledge. The results of the TG-Noise are expected for the time after the completion of the present report and will be decisive for the assessment for the evaluation of the Good Environmental Status with regard to continuous underwater noise. The standardised methods and criteria will be used to design and implement measures to avoid and reduce impacts across Europe.

In recent years, studies have carried out concepts to avoid and reduce the impact of sound emitted by ships and have developed projects of a model character that provide indications on possible measures (Erbe et al., 2012, Frisk, G.V., 2012, Leaper & Renilson, 2012, McKenna et la. 2013, Leaper et al., 2014, Williams et al., 2014, Wright, A.J., 2014, Huntington et al., 2015, Mikhalevsky et al., 2015, Spence & Fischer, 2017, Wilson et la., 2017, Erbe et al., 2020, Leaper R., 2020, Pine et al., 2020).

As early as 2014, the IMO addressed adverse impacts on the marine environment and issued guidelines for the reduction of underwater noise from commercial shipping (IMO, 2014). Among the pilot projects dealing with the design and implementation of noise abatement measures by shipping, Project ECHO through the Port of Vancoucer, in Canada was initiated. The voluntary speed reduction has shown first positive signals with regard to the occurrence and behaviour of southern resident killer whales (ECHO ANNUAL REPORT, 2020, RUTH ET AL., 2019).

Shipwrecks can result in the release of environmentally hazardous substances such as oil and chemicals. Direct mortality as a result of oil pollution is only expected in major oil spills (GERACI and ST AUBIN 1990; FROST and LOWRY, 1993). Oil spills can cause lung and brain damage in marine mammals. An observed long-term consequence of an oil spill has also been increased juvenile mortality in harbour seals.

Loss of cargo can also lead to contamination with toxic substances. Even during normal ship operation, oil and oil residues, lipophilic detergents from tank cleaning, ballast water containing non-indigenous organisms and solid waste enter the marine environment (OSPAR, 2000). Pollutants discharged from ships into the sea can accumulate in food chains, contributing to pollution and contamination. Impacts on marine mammals via the accumulation of pollutants in food chains are also possible.

Effects at population level can hardly be assessed according to current knowledge. It is therefore recommended that all uses always follow the precautionary principle (Evans, 2020).

Non-implementation of the plan would not affect the existing or described impacts of shipping on harbour porpoise, harbour seal and grey seal.

3.1.5 Seabirds and resting birds

The impacts of shipping on seabirds and resting birds include visual disturbance, attraction effects and collisions, as well as pollution and the introduction of invasive species.

Visual disturbance can cause shying or avoidance reactions in species that are sensitive to disturbance. According to a recent study by FLIEßBACH et al. (2019), red-throated divers, black guillemots, black-throated divers, velvet scoters and red-breasted mergansers are among the most sensitive species to ship traffic. The most common response is to fly up. Flying distances vary across species and individuals and can be related to various individual and ecological factors (FLIEßBACH et al. 2019). The sensitivity of divers to ships is also known from other studies (GARTHE & HÜPPOP 2004, Schwemmer ET al. 2011, Mendel et al. 2019, Burger ET AL. 2019).

Direct impacts on seabirds due to visual disturbance are to be expected in particular along busy traffic routes or traffic separation areas. The effects of shipping through visual disturbance on seabirds and resting birds are regionally and temporally dependent on the occurrence of ships. Findings on divers' reactions to ships indicate that the duration and intensity of the startle response may be related to the type of ship and associated factors such as ship speed (BURGER et al. 2019).

Shipping traffic can release oil and oil residues, lipophilic detergents from tank cleaning, ballast water containing non-indigenous organisms, and solid waste into the marine environment (OSPAR 2000). WIESE AND RYAN (2003) found signs of chronic oil pollution in seabirds. Nearly 62% of all seabird deaths in the southeastern coasts of Newfoundland in 1984-1999 were contaminated with oil from ship operations. Alcids were the most frequently contaminated with oil.

Loss of cargo can also lead to contamination with toxic substances. Pollutants discharged from ships into the sea can accumulate in the food chain and thus contribute to pollution and contamination. Shipwrecks can also result in massive spills of environmentally hazardous substances such as oil and chemicals.

Various effects are known to be caused by oil spills. After the Prestige accident in 2003, for example, up to 50% less breeding success was observed at breeding colonies affected by oil pollution compared to undisturbed breeding colonies (VELANDO et al. 2005a). Indirect effects of the Prestige accident on the breeding success of the cormorant were also observed: high contamination in sediment, plankton and benthos reduced the sand eel population. The reduction of sand eels has in turn had an impact on the breeding success of the crow cormorant. Fewer breeding pairs successfully bred in 2003 than expected from long-term data. The condition of the chicks was also exceptionally weak due to lack of food or reduced food quality (VELANDO et al. 2005b).

The above-mentioned impacts on seabirds and resting birds occur independently of the non-implementation or implementation of the plan.

3.1.6 Migratory birds

For migratory birds, impacts of shipping are possible through visual stimuli and the input of pollutants. Migratory birds can be attracted by ship lighting at night. This is especially true for nights with poor visibility due to clouds, fog and rain. The possible consequences are collisions.

A risk to migratory birds from oil or pollutants is not very likely. Only those migratory birds would be affected, e.g. seabirds that interrupt their migration by watering, either to feed or to wait out bad weather conditions (such as headwinds and poor visibility). The consequence would be that the birds die due to the oiling of their plumage and the absorption of oil into the gastrointestinal tract due to their preening behaviour or the consumption of oily food.

The above-mentioned impacts on migratory birds occur independently of the non-implementation or implementation of the plan.

3.1.7 Bats and bat migration

Effects of shipping on bats are largely unknown. There are only isolated reports of bats being found on ships. WALTER et al. (2005) have summarised such observations/findings on ships in the context of investigations for offshore wind energy projects. Accordingly, it is assumed that attraction effects by ships can occur.

Insects can be attracted to ships by lighting and heat generation. Bats that are looking for food can subsequently be attracted by the insects. It is also assumed that migrating bats also visit ships to rest. However, this does not necessarily mean that there is a risk of collision.

No other direct or indirect effects of shipping on bats are known. The attraction effects already described can occur at most regionally and for a limited period of time.

The above-mentioned impacts on bats occur regardless of whether the plan is not implemented or is implemented.

3.1.8 Air

Shipping causes pollutant emissions, especially nitrogen oxides,
sulphur dioxides, carbon dioxide and soot particles. These can have a negative impact on air quality. However, this is independent of the non-implementation or implementation of the ROP.

3.1.9 Climate

The pollutant emissions from shipping described in Chapter 3.1.8contribute to climate change. Globally, the share of maritime transport in greenhouse gas emissions is 2.2%. (BMU, 2020).

However, this is independent of the non-implementation or implementation of the ROP.

3.1.10 Cultural assets and other material assets

In connection with shipping, measures to deepen, shift or widen fairways, for example through dredging, can lead to the destruction of the neighbouring underwater cultural heritage. Furthermore, the underwater cultural heritage is threatened, especially in shallower waters, as ship propellers can cause turbulence in the sediment, which has an erosive effect on the layers of finds. Destruction can also be caused by anchor-laying, especially during construction measures with anchor-positioned working vessels.

Indirectly, the increasing trend since 1970 of introducing non-native species via ballast water and on the ship's hull itself (Gollasch 2003) poses the greatest threat to the underwater heritage. Three species of teredinids are active in native waters, among them Teredo navalis as the best-known representative, which was already detected in the Baltic Sea from 1872 onwards and has been causing great damage to wooden harbour structures, ship walls and pile works ever since. Its spread is bound to tolerance ranges with regard to salinity, water temperature and oxygen (cf. Björdal et al. 2012, 208; Lippert et al. 2013, 47). However, shipping can lead to the immigration of further destructive organisms that are adapted to a different tolerance range and can penetrate previously undisturbed areas.

An indirect consequence of recreational shipping is recreational diving in the EEZ. In the past, objects were taken from historical wrecks or even deliberately dismantled, as the example of the wreck of the SMS Mainz, which was looted by Dutch divers in 2011, shows (Huber & Knepel 2015).

In the past, the Explosive Ordnance Disposal Service blasted wrecks from the time of the World Wars on the suspicion that there might still be ammunition on board. Here, safety aspects must be weighed against the protection of cultural heritage.

3.2 Wind energy at sea

The increasing demand for space by offshore wind energy and the ambitious goals of the Federal Government for the use of wind energy at sea were the main reasons for the preparation of the 2009 maritime spatial plans for the German EEZ of the North Sea and Baltic Sea. The preparation of the spatial plans was an explicitly mentioned measure to promote the expansion of renewable energies.

When the maritime spatial plans were enacted in 2009, a first offshore wind farm, the alpha ventus test field, was nearing completion with 12 individual turbines. In the meantime, 21 wind farms with a total of 1,399 turbines and an installed capacity of approx. 7.2 GW in (trial) operation.

The first offshore wind turbines had a rated output of 2.3 to 5 MW. Larger rotors and more load-bearing substructures have led to a significant increase in rated power over time.

Specialist planning:

With the FEP 2019 (currently being updated and amended), there is an up-to-date technical plan to guide the planning of offshore wind energy development and electricity grid connections.

The current draft FEP defines areas N-1 to N-13 for offshore wind energy in the North Sea EEZ to achieve the expansion target of 20 GW by 2030. The increased expansion path for offshore wind energy results from the draft law amending the Wind Energy at Sea Act and other regulations adopted by the Federal Cabinet on 3 June 2020. Various impacts on the marine environment may arise in connection with the construction and operation of wind turbines, including local habitat loss due to permanent surface sealing, scouring and barrier effects and a resulting loss of habitat for avifauna. Also to be considered are potential impacts from maintenance and service traffic.

For the assessment of the specifications for offshore wind energy, the following possible impacts are examined:

Table 19: Potential impacts from offshore wind energy (t = temporary).

Use	Effect	Potential impact	Protected goods																
			Benthos	Fish	Seabirds and	Migratory birds	Marine mammals	Bats	Plankton	Biotope types	Biodiversity	Floor	Area	Water	Air	Climate	Man/ Health	Cultural and mate-	Landscape
Areas for offshore wind energy	Placement of hard substrate (foundations)	Habitat modification	x	x			x		x	x	x	x							
		Habitat and land loss	x	x			x			x	x	x	x					x	
		Attraction effects, increase in species diversity, change in species composition	x	x	x		x		x		x								
		Change in hydrographic conditions	x	x			x		x					x					
	Scouring/sediment rearrangement	Habitat modification	x	x					x	x		x	x						
	Sediment resuspension and turbidity plumes (construction phase)	Impairment	x t	x t	x t				x t					x t					
		Physiological effects and chilling effects		x t			x												
	Resuspension of sediment and sedimentation (construction phase)	Impairment	x t	x t					x t					x t					
	Noise emissions during pile driving (construction phase)	Impairment/ scare effect		x t			x												
		Potential disruption/damage		x t			x												
	Visual disturbance due to construction operations	Local scouring and barrier effects		x t	x t														
	Obstacle in airspace	Scare effects, habitat loss			x														
		Barrier effect, collision			x	x		x											x
	Light emissions (construction and operation)	Attraction effects, collision			x	x		x											x
	Wind farm-related shipping traffic (maintenance, construction traffic)	See Shipping	x	x	x	x	x	x	x	x	x	x	x t	x	x	x	x	x	

3.2.1 Soil

The use of "offshore wind energy" has the following effects on the seabed:

Wind turbines

The wind turbines and platforms have a localised environmental impact on soil. The sediment is only permanently affected in the immediate vicinity by the installation of the foundation elements (including scour protection if necessary) and the resulting land use. To protect against scouring, either scour protection in the form of so-called mudmats or riprap is applied around the foundation elements, or the foundation piles of deep foundations are inserted correspondingly deeper into the ground. Wind turbines and platforms are currently installed almost exclusively as deep foundations. However, the use of other foundation structures such as gravity foundations or suction bucket foundations can also be considered. In deep foundations, the foundation of a wind turbine or platform is anchored in the seabed using one or more steel piles. The foundation piles are generally driven into the ground. Suction bucket foundations obtain their stability by creating a negative pressure in the cylindrical foundation structure, which does not need to be driven. Above the seabed, both deep foundations and suction bucket foundations typically use a trussed frame structure of steel pipes and struts, called a jacket structure, as a stiffening structure.

Construction-related impacts: During the foundation of the wind turbines and platforms, sediments are briefly stirred up and turbidity plumes form. The extent of the resuspension essentially depends on the fine grain content in the soil. As the surface sediments of the North Sea EEZ within the priority and reserved areas are mainly fine and medium sands, and in places also coarse sands, the released sediment will quickly settle directly at the construction site or in its immediate vicinity. The expected adverse effects due to increased turbidity will remain limited to a small area. In the short term, pollutants and nutrients can be released from the sediment into the groundwater. The possible pollutant input into the water column from stirred-up sediment is negligible due to the relatively low proportion of fine grains (silt and clay) and the low pollutant load as well as the relatively rapid resedimentation of the sands. This also applies against the background that the sandy sediments are naturally (e.g. during storms) stirred up and redeposited by swells coming into contact with the ground and corresponding currents. Impacts in the form of mechanical stress on the soil due to displacement, compaction and vibrations, which are to be expected in the course of the construction phase, are estimated to be low due to their small scale.

Due to the installation, the seabed is only permanently sealed locally to a small extent by the insertion of the foundation elements of deep foundations for wind turbines or platforms. The affected areas essentially comprise the diameter of the foundation piles with any necessary scour protection. The land use (sealing) for transformer platforms and converter platforms, which are almost exclusively founded on jacket constructions (without scour protection), amounts to approx. 600 ^{m2} to 900 m^2 depending on the size of the platform. Wind turbines are also almost exclusively realised as deep foundations. By far the most common foundation variant here is the monopile. With a monopile diameter of 8.5 m, including scour protection, a land use of about 1400 ^{m2} is achieved. The area taken up by suction bucket foundations corresponds roughly to that of a monopile.

In the case of a gravity-founded platform, the surface sealing caused by the installation is significantly greater than in the case of deep foundations. Including scour protection measures, ten to twenty times the area is likely to be taken up compared to a deep-foundation platform.

Due to the interaction of the foundation and the hydrodynamics in the immediate vicinity of the plant, the sandy sediments may be permanently stirred up and rearranged. Scouring may occur in the immediate vicinity of the facilities. According to previous experience, permanent sediment redistribution due to currents is only to be expected in the immediate vicinity of the platform. According to the findings from the accompanying geological investigations in the offshore test field "alpha ventus" (LAMBERS-HUESMANN & ZEILER 2011) and on the research platforms FINO1 and FINO3, these will occur locally around the individual foundation piles (local scour). Due to the prevailing ground conditions and the predicted spatially limited perimeter of the scour, no significant substrate changes are to be expected.

Submarine cable systems

Due to construction, the turbidity of the water column increases as a result of the sediment stirring up during the cable laying work, which is distributed over a larger area due to the influence of the tidal currents. The extent of the resuspension depends mainly on the laying method and the fine grain content in the soil. Due to the prevailing sediment characteristics in the North Sea EEZ, most of the released sediment will settle directly at the construction site or in its immediate vicinity. In the process, the suspension content will decrease again to the natural background levels due to dilution effects and sedimentation of the whirled-up sediment particles. The expected impairments due to increased turbidity remain locally limited. The results of investigations from various procedures in the North Sea show that the seabed levels out again 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 the low heavy metal concentrations in the sediment. Impacts in the form of mechanical stress on the soil due to displacement, compaction and vibrations that are to be expected in the course of the construction phase are assessed as low due to their small-scale nature.

Due to operation, energy losses may occur in the form of heat dissipation to the surrounding sediment. The heat emission results from the thermal losses of the cable system during energy transmission.

In summary, the potential impacts of the currently planned wind turbines, platforms and submarine cable systems on soil as a protected resource are narrowly localised and arise independently of spatial planning.

ROP and FEP - priority areas and reserved areas

The current status with regard to planning the expansion of offshore wind energy is set out in the FEP 2019, which - spatially speaking - covers the *priority areas for* wind energy in the ROP. The impacts described above were therefore assessed for this study area in the course of preparing the FEP 2019. As a result, no significant impacts on soil as a protected resource were identified, especially since the seabed in the affected areas is predominantly poorly structured with a homogeneous sediment distribution of fine and medium sands.

If the FEP is not implemented, a spatially less coordinated laying and possibly a larger number of cable systems or longer submarine cable systems would have to be expected. This could lead to a higher land use and thus to an increase in the potential impacts on soil as a protected resource compared to the implementation of the FEP. If the FEP is not implemented, an increased number of cable crossings with operational submarine cables would also have to be expected. This would necessitate increased placement of riprap even in areas with predominantly homogeneous sandy seabed. In the case of crossing decommissioned telecommunication cables, these are usually cut so that the cut cable ends have to be secured with concrete weights against floating. This would result in additional surface sealing and placement of artificial hard substrate.

In addition to priority areas, the ROP also provides for *reserved areas for the* North Sea EEZ. If the plan is not implemented, a less coordinated expansion of offshore wind energy can also be expected in these areas.

3.2.2 Benthos and biotope types

Benthic communities and biotopes would be affected in parts by the impacts of various uses even if the plan were not implemented. In addition, it is to be expected that the warming of the water, which has already begun as a result of climate change, will continue in the future. This also has an impact on benthic communities. This may lead to the settlement of new species or to a shift in the species spectrum as a whole. However, this development is independent of the non-implementation or implementation of the plan.

If the plan is not implemented, a spatially less coordinated planning of the wind farms would have to be expected. As a result of not implementing the plan, there could be a comparatively higher land take and thus an increase in possible impacts on benthos and biotopes compared to implementing the plan. Possible impacts result from the placement of the foundations of the wind turbines and platforms. During the construction phase, impacts on benthic communities could occur due to direct disturbance of near-surface sediments, pollutant inputs, resuspension of sediment, formation of turbidity plumes and increase in sedimentation.

In the vicinity of the foundations of the plants and platforms, changes in the existing species composition may occur due to the introduction of artificial hard substrate.

Since the provisions of the plan aim to minimise the use of the seabed, the protection of benthos and biotopes would probably be more difficult to ensure if the plan were not implemented than if it were.

3.2.3 Fish

The construction-, installation- and operation-related impacts of OWPs on fish fauna are spatially and partly also temporally limited and are essentially concentrated on the area of the planned project. The effects of the different wind farm phases are described in detail below.

<u>Construction-related impacts</u>

- Noise emissions from driving the foundations
- Sedimentation and turbidity plumes

In the area of the project, construction-related **noise emissions are** to be expected from the use of ships, cranes and construction platforms as well as from the installation of the foundations and, if necessary, from the installation of scour protection. It is known from the literature that pile driving underwater produces high sound pressures in the low-frequency range. All fish species and their life stages studied so far can perceive sound as particle movement and pressure changes (KNUST et al. 2003, KUNC et al. 2016, WEILGART 2018, POPPER & HAWKINS 2019). Depending on the intensity, frequency and duration of sound events, sound could have a direct negative impact on fish development, growth and behaviour, or override environmental acoustic signals that are sometimes crucial for fish survival (KUNC ET AL. 2016, WEILGART 2018, JONG ET AL. 2020). However, the majority of previous evidence on the effects of sound on fish comes from laboratory studies (WEILGART 2018). The range of perception and possible species-specific behavioural responses in marine habitat have been little studied. The construction-related impacts of wind farms on fish fauna are limited in space and time. It is likely that during the construction phase, short, intense sound events - especially during the installation of the foundations - will cause fish to become distressed. 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 1,400 m or closer from a pile driving sound source without any sound protection (DE BACKER et al. 2017). Such studies indicate that significant disturbance or even killing of individual fish in the vicinity of pile driving sites is possible. Hydroacoustic measurements showed 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). After temporary displacement, however, the fish are likely to return after the sound-intensive construction measures have ended. Studies on sound effects on fish by NEO et al. (2016) showed that the animals largely returned to their usual behaviour 30 min after the auditory stimuli.

The construction activities of the foundations of wind turbines as well as the transformer platform and the cabling within the park result in **sediment turbulence and turbidity plumes**, which - albeit for a limited period of time and depending on the species - can have physiological effects on fish fauna, especially on fish spawning. However, significant impacts on fish fauna due to sediment turbulence, turbidity plumes and sedimentation are not to be expected. Detailed information on this can be found in Chapter 3.4.3

<u>Plant-related effects</u>

- Land use
- Placement of hard substrate
- Fishing ban
- Operating sound

The construction of the foundations of the WTGs and technical platforms as well as the scour protection will overbuild habitats and they will no longer be available for fish. There is a permanent **loss of habitat** for demersal fish species and their food base, the macrozoobenthos, due to local overbuilding. However, this habitat loss is limited to the immediate, small-scale location of the individual WTGs and platforms.

The construction of wind farms changes the structure of the often uniformly sandy seabeds of the North Sea through newly introduced hard substrate (foundations, scour protection). An **attraction effect of artificial reefs** on fish has been observed in the majority of cases (METHRATTA & DARDICK 2019). In the vicinity of Norwegian oil platforms, higher catches of cod and saithe were achieved than before their construction (VALDEMARSEN 1979, SOLDAL et al. 2002). Increased densities of flatfish have been found near artificial reefs (POLOVINA & SAKI 1989). At the monopiles of the existing wind farm "Horns Rev I", according to expert reports and video recordings of the accompanying monitoring, a large number of fish species occur which use the artificial hard substrate (LEONHARD et al. 2011). In addition to this positive effect, the change in dominance ratios and size structure within the fish community due to 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 radius of action is assumed to be 200 to 300 m for pelagic and up to 100 m for benthic fish (GROVE et al. 1989). STANLEY & WILSON (1997) found increased fish densities within 16 m of a drilling platform in the Gulf of Mexico. Transferred to the foundations of wind turbines, it can be assumed, due to the distance of the individual turbines from each other, that each individual foundation, regardless of the type of foundation, acts as a separate, relatively unstructured substrate and that the impact does not encompass the entire wind farm area.

COUPERUS et al. (2010) detected up to 37 times higher concentrations of pelagic fish in the vicinity (0-20 m) of wind turbine foundations using hy-

droacoustic methods compared to the areas between the individual wind turbines. REUBENS et al. (2013) found significantly higher concentrations of Franzosendorschen *Trisopterus luscus at the foundations* than over the surrounding soft substrate, feeding predominantly on the fouling on the foundations. GLAROU et al. (2020) reviewed 89 scientific studies on artificial reefs, 94% of which demonstrated positive or no effects of artificial reefs on fish fauna abundance and biodiversity. In 49% of the studies, locally increased fish abundance was recorded after the construction of artificial reefs. Reasons for increased fish abundance on artificial reefs and in OWPs could be the locally more extensive food availability and protection from currents and predators (GLAROU et al. 2020).
Recent biological studies have shown that cod reproduce in the wind farms of the "Nördlich Helgoland" cluster (GIMPEL et al. in prep.). It remains to be clarified to what extent the increased productivity can be transferred to other fish species.

The **elimination of fishing** due to the anticipated prohibition of navigation in the wind farm areas could have a further positive effect on the fish population. Associated negative fishing effects, such as disturbance or destruction of the seabed as well as catch and bycatch of many species, would be eliminated. Due to the lack of fishing pressure, the age structure of the fish fauna within the project area could develop into a more natural distribution again, so that the number of older individuals increases. In addition to the absence of fishing, an improved food basis for fish species with a wide variety of diets would also be conceivable. The vegetation of the wind turbines with sessile invertebrates could favour benthophagous species and make a larger and more diverse food source accessible to the fish (LINDEBOOM et al. 2011). This could improve the condition of the fish, which in turn would have a positive effect on fitness. Currently, research is needed to translate such cumulative effects to the population level of fish. To date, the effects on fish fauna that could result from the elimination of fishing in the area of offshore wind farms have not been quantitatively investigated, and results for some fish species are still pending (GIMPEL et al. in prep.).

For the operational phase of the OWPs, it can be assumed that, due to the prevailing meteorological conditions in the North Sea, almost permanent operation of the wind turbines will be possible. The sound emitted by the WTs is therefore expected to be permanent. Studies by MATUSCHEK et al. (2018) on the **operational noise of** wind farms showed that low-frequency noise can be measured at a distance of 100 m from the respective turbine. With increasing distance to the turbine, the sound levels towards the centre of the wind farm decreased in all wind farms. However, outside the wind farms, at a distance of 1 km, higher levels were measured than in the centre of the wind farm. In general, the investigations revealed that the underwater sound emitted by the turbines cannot be clearly separated from other sound sources, such as waves or ship noise (MATUSCHEK et al. 2018). Previous studies on the effects of continuous noise emissions on fish could not provide clear evidence of negative effects, such as persistent stress reactions (WEILGART 2018).

The objectives and principles of the ROP on offshore wind energy, in particular orderly and sustainable spatial development, would not be met if the plan were not implemented. The protection of the marine environment, e.g. by taking into account the ecosystem approach and the precautionary principle, could be more difficult to ensure if the plan is not implemented.

3.2.4 Marine mammals

<u>Construction-related</u>: Hazards may be caused to harbour porpoises, grey seals and harbour seals by noise emissions during the construction of offshore wind turbines and the transformer station if no avoidance and mitigation measures are

taken. Depending on the foundation method, impulse sound or continuous sound can be introduced. The input of impulse sound, which occurs e.g. when driving piles with hydraulic hammers, has been well studied. The current state of knowledge on impulse sound contributes significantly to the development of technical sound reduction systems. In contrast, the current state of knowledge on the input of continuous sound as a result of the installation of foundation piles using alternative methods is very limited.

The Federal Environment Agency (UBA) recommends compliance with noise protection values during the construction of foundations for offshore wind turbines. The sound event level (SEL) should not exceed 160 dB (re 1 µPa) outside a circle with a radius of 750 m around the pile driving or installation site. The maximum peak sound pressure level should not exceed 190 dB if possible. The UBA recommendation does not contain any further specifications of the SEL noise protection value (http://www.umweltdaten.de/publikationen/fpdf-l/4118.pdf, as of May 2011).

The noise protection value recommended by the UBA has already been developed through preliminary work of various projects (UNIVERSITY OF HANOVER, ITAP, FTZ 2003). For precautionary reasons, "safety margins" were taken into account, e.g. for the interindividual dispersion of hearing sensitivity documented so far and above all because of the problem of repeated exposure to loud sound impulses, such as those that will occur during the pile driving of foundations (ELMER et al., 2007). There are currently only very limited reliable data available to assess the impact duration of pile driving noise. However, pile driving activities that can last several hours have a much higher damage potential than a single pile driving impact. At present, it is unclear how much of a reduction to the above-mentioned limit value should be applied to a sequence of individual events. A reduction of 3 dB to 5 dB for each tenfold increase in the number of pile driving impulses is discussed in expert circles. Due to the uncertainties shown here in the evaluation of the impact duration, the limit value used in licensing practice is below the limit value proposed by SOUTHALL et al. (2007).

Within the framework of establishing measurement regulations for recording and assessing underwater noise from offshore wind farms, the BSH has concretised and standardised as far as possible the specifications from the UBA recommendation (UBA 2011) and from the findings of the research projects with regard to noise protection values. In the BSH's measurement regulations for underwater sound measurements, the SEL5 value is defined as the assessment level, i.e. 95% of the measured individual sound event levels must be below the statistically determined SEL5 value (BSH 2011). The extensive measurements within the scope of the efficiency control show that the SEL5 is up to 3 dB higher than the SEL50. Thus, by defining the SEL5 value as an assessment level, a further tightening of the noise protection value was undertaken in order to take the precautionary principle into account.

Thus, based on an overall assessment of the available expert information, the BSH assumes that the sound event level (SEL5) 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 exclude adverse effects on harbour porpoises with the necessary certainty.

First results on the acoustic resilience of harbour porpoises were obtained in the MINOSplus project. After sonication with a maximum reception level of 200 pk-pk dB re 1 µPa and an energy flux density of 164 dB re 1 µPa2/Hz, a temporary hearing threshold shift (so-called TTS) was detected for the first time in a captive animal at 4 kHz. Furthermore, the hearing threshold shift was found to last for more than 24 hours. Behavioural changes were already registered in the animal at a reception level of 174 pk-pk dB re 1 µPa

(LUCKE et al. 2009). However, in addition to the absolute loudness, the duration of the signal also determines the effects on the exposure limit. The exposure limit decreases with increasing duration of the signal, i.e. continuous exposure can cause damage to the animals' hearing even at lower volumes. Based on these latest findings, it is clear that harbour porpoises suffer a hearing threshold shift at a level of 200 decibels (dB) at the latest, which can possibly also lead to damage to vital sensory organs.

The scientific findings that have led to the recommendation or establishment of so-called noise protection values are mostly based on observations in other cetacean species (SOUTHALL et al. 2007) or on experiments on harbour porpoises in captivity using so-called airguns or air pulsers (LUCKE et al. 2009).

Without the use of sound mitigation measures, significant disturbance of marine mammals during the pile driving of the foundations cannot be ruled out. The pile driving of the wind turbines and the transformer station will therefore only be permitted in the specific approval procedure with the use of effective noise reduction measures. Principles are included for this purpose. These principles state that pile-driving work during the installation of the foundations of offshore wind turbines and platforms may only be carried out in compliance with strict noise reduction measures. In the actual approval procedure, extensive noise reduction measures and monitoring measures will be ordered to ensure compliance with the applicable noise protection values (sound event level (SEL) of 160 dB re 1µPa and maximum peak level of 190 dB re 1µPa at a distance of 750 m from the pile driving or installation site). Suitable measures shall 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 underwater noise mitigation show that the use of suitable systems can significantly reduce or even completely avoid impacts on marine mammals caused by sound (Bellmann, 2020).

Taking into account the current state of knowledge, conditions will be imposed as part of the specification of the foundation types to be constructed in the approval procedure, with the aim of avoiding impacts on harbour porpoises caused by sound as far as possible. The extent of the required conditions will be determined at the approval level on a site- and project-specific basis by examining the design of the respective project on the basis of the requirements of species protection law and site protection law.

In addition, the BMU's noise protection concept has been in force since 2013. The approach of the BMU's noise protection concept is habitat-related. According to the noise abatement concept, pile driving activities are to be coordinated in such a way that sufficiently large areas, particularly within the German EEZ in the North Sea and especially within the protected areas and the main concentration area of the harbour porpoise in the summer months, are kept free from impacts caused by pile driving noise.

The BSH's approval notices contain two orders to protect the marine environment from noise pollution caused by pile driving:

a) Reduction of noise input at source: Mandatory use of low-noise working methods in accordance with the state of the art when installing foundation piles and mandatory restriction of noise emissions during pile driving. The order primarily serves to protect marine species from impulsive noise emissions by avoiding killing and injury.
b) Avoidance of significant cumulative impacts: The dispersion of sound emissions must not exceed defined proportions of the area of the German EEZ and nature conservation areas. This ensures that sufficient high-quality habitats are available to animals for escape at all

times. The arrangement primarily serves to protect marine habitats by avoiding and minimising disturbances caused by impulsive sound emissions.

The order under a) specifies the mandatory noise protection values to be complied with and the maximum duration of the impulsive sound input, the use of technical sound reduction systems and deterrent measures as well as the extent to which the protective measures are to be monitored.

Under order b), provisions are made, inter alia, for the avoidance and reduction of significant cumulative impacts or disturbances of the harbour porpoise population that may be caused by impulsive sound inputs. The regulations are derived from the BMU's concept for the protection of harbour porpoises in the German North Sea EEZ (BMU, 2013).

- It shall be ensured with the necessary certainty that at any time no more than 10% of the area of the German EEZ of the North Sea and no more than 10% of a neighbouring nature conservation area is affected by noise-inducing pile driving activities.
- During the porpoise's sensitive period from 1 May to 31 August, it shall be ensured with the necessary certainty that no more than 1% of sub-area I of the nature conservation area "Sylt Outer Reef - Eastern German Bight" with its special function as a nursery area is affected by sound-intensive pile-driving work for the foundation of the piles from disturbance-triggering sound inputs.

In order to ensure the protection of marine habitats, additional measures may be required during the foundation work in accordance with the noise protection concept of the BMU (2013), depending on the location of a project in the German EEZ or its proximity to nature conservation areas. Additional measures will be issued by the BSH within the scope of the third construction approval, taking into account the site- and project-specific characteristics.

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

Especially during pile driving, direct disturbance of marine mammals at the individual level is to be expected locally around the pile driving site and for a limited period of time, whereby - as explained above - the duration of the work also has an impact on the exposure limit. In order to prevent a resulting threat to the marine environment, the specific approval procedure must include an order to limit the effective pile-driving time (including the entanglement) to a minimum. The effective pile-driving time to be complied with in each case (including deterrence) will be specified later in the approval procedure on a site- and installation-specific basis. In addition, coordination of noise-intensive works with other construction projects is reserved within the framework of the enforcement procedure in order to prevent or reduce cumulative effects.

Based on the function-dependent importance of the areas for harbour porpoises and taking into account the noise protection concept of the BMU (2013) for the avoidance of disturbances and cumulative effects, the regulations made in the area development plan (FEP, 2019), the specifications within the framework of the suitability test and the requirements within the framework of individual approval procedures for the reduction of noise inputs, the potential impacts of noise-intensive construction work on harbour porpoises are assessed as not significant. The safeguarding of open space in nature conservation areas, the designation of the reserved area and the implementation of the requirements from the

BMUB noise protection concept rule out any adverse effects on important feeding and breeding grounds for harbour porpoises.

According to current knowledge, operational noise from the wind turbines and the transformer platform has no impact on highly mobile animals such as marine mammals. The investigations carried out as part of the operational monitoring for offshore wind farms have so far not provided any indications of avoidance by wind farm-related shipping traffic. Avoidance has so far only been detected during the installation of the foundations, which may be related to the large number and varying operating conditions of vehicles at the site.

The standardised measurements of the continuous sound input from the operation of the wind farms, including the wind farm-related shipping traffic, have shown that low-frequency noise can be measured at a distance of 100 m from the respective wind turbine. With increasing distance to the wind turbine, however, the noise of the wind turbine is only insignificantly different from the ambient noise. Even at a distance of 1 km from the wind farm, higher sound levels are always measured than in the centre of the wind farm. The investigations have clearly shown that the underwater sound emitted by the turbines cannot be clearly identified from other sound sources, such as waves or ship noise, even at short distances. The wind farm-related ship traffic could also hardly be differentiated from the general ambient sound, which is introduced by various sound sources, such as other ship traffic, wind and waves, rain and other uses (MATUSCHEK et al. 2018).

All measurements showed that not only the offshore wind turbines emit sound into the water, but also various natural sound sources, such as wind and waves (permanent background sound), can be detected in the water over a broad band and contribute to the broadband permanent background sound.

In the measurement regulations for recording and evaluating underwater sound (BSH, 2011), a level difference between impulse and background sound of at least 10 dB is required for a technically unambiguous calculation of impulse sound during pile driving. For the calculation or evaluation of continuous sound measurements, however, there is no minimum requirement in this respect due to a lack of experience and data. In the airborne sound range, a level difference of at least 6 dB between system and background sound is required for the unambiguous assessment of system or operating noise. If this level difference is not achieved, a technically unambiguous assessment of the system noise is not possible or the system noise is not clearly distinguishable from the background noise level.

The available results from the measurements of underwater sound show that such a 6 dB criterion based on airborne sound can at most be fulfilled in the immediate vicinity of one of the turbines. However, this criterion is no longer fulfilled even at a short distance from the edge of the wind farm. As a result, the sound emitted by the operation of the turbines is not clearly distinguishable from the existing ambient sound from an acoustic point of view outside the project areas.

The biological relevance of continuous sound on marine species and especially on harbour porpoises has not yet been reliably clarified. Continuous sound is the result of emissions from various anthropogenic uses, but also from natural sources. Reactions of animals in the immediate vicinity of a source such as a moving ship are to be expected and can occasionally be observed. Such reactions are even essential for survival in order to avoid collisions, among other things. In contrast, reactions not observed in the immediate vicinity of sound sources can no longer be assigned to a specific source.

Behavioural changes are in their vast majority the result of a variety of influences. Noise can certainly be a possible cause of behavioural changes. However, behavioural changes are primarily driven by the survival strategies of animals to capture food, escape predators and to communicate with conspecifics. For this reason, behavioural changes always occur situationally and in varying degrees.

There are indications in the literature of possible behavioural changes due to ship noise, but the results are not valid for drawing conclusions on the significance of behavioural changes or even for developing and implementing appropriate mitigation measures.

However, scientific reviews of the existing literature on possible effects of ship noise on cetaceans but also on fish clearly point to the lack of comparability, transferability and reproducibility of results (Popper & Hawkins, 2019, Erbe et la. 2019).

It is known from oil and gas platforms that the attraction of various fish species leads to an enrichment of the food supply (Fabi et al., 2004; Lokkeborg et al., 2002). Monitoring of harbour porpoise activity in the immediate vicinity of platforms has 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 wind turbines and the transformer platform is very likely to attract marine mammals.

As a result of the SEA, it can be stated that, according to current knowledge, no significant impacts on marine mammals are to be expected from the construction and operation of wind turbines and the transformer platform.

The non-implementation of the plan would have had an influence on the existing or described impacts of wind energy production on harbour porpoises, harbour seals and grey seals, as it would not have been possible to plan expansion in an orderly manner, taking into account specific objectives and principles.

3.2.5 Seabirds and resting birds

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

Species sensitive to disturbance can be expected to avoid the construction site, the intensity of which varies according to the species and can most likely be attributed to a reaction to the construction-related shipping traffic.

Construction-related turbidity plumes occur locally and for a limited time. Attraction effects due to the lighting of the construction site and the construction site vehicles cannot be ruled out.

Operational and installation-related: Erected wind turbines can be an obstacle in the airspace and can also cause collisions with the vertical structures of seabirds and resting birds (Garthe 2000). To date, the extent of such occurrences is difficult to estimate, as it is assumed that a large proportion of collided birds do not land on a fixed structure (Hüppop et al. 2006). For species sensitive to disturbance such as red-throated divers and black-throated divers, however, the risk of collision is estimated to be very low, as they do not fly directly into or near the wind farms due to their avoidance behaviour. Furthermore, factors such as manoeuvrability, flight altitude and the proportion of time spent flying determine the collision risk of a species (Garthe & Hüppop 2004). The collision risk for seabirds and resting birds must therefore be assessed differently depending on the species.

The corresponding height parameters of the turbines are an important indicator for estimating the potential collision risk for seabirds and resting birds with wind turbines at sea. In the ROP, bandwidths for the height parameters of currently installed or potential turbine types were included in accordance with the current technical developments of wind turbines (cf. Chapter 4.2). Here, on the one hand, wind farm projects are taken into account that are already in operation, as well as those that will go into operation in the transitional system and the first commissioning years of the central system in zones 1 and 2. Another turbine spectrum represents turbines that could potentially be installed in future wind farm projects in zones 3 to 5. For already realised or future wind farm projects in Zones 1 and 2, data or assumptions are available for 5 to 12 MW turbines with a hub height of 100 to 160 m and, based on rotor diameters of 140 m to 220 m, a total height of 170 m to 270 m. For wind farm projects in Zones 3 and 5, data or assumptions are available for 5 to 12 MW turbines with a hub height of 100 to 160 m and, based on rotor diameters of 140 m to 220 m, a total height of 170 m to 270 m. For wind farm projects in Zones 3 to 5, assumptions are made for 12 to 20 MW turbines, which have a hub height of 160 to 200 m and, based on rotor diameters of 220 m to 300 m, a total height of 270 m to 350 m. This means that the lower rotor-free height is between 100 m and 350 m. The lower rotor-free height is between 170 m and 350 m. This means that the lower rotor-free area from the water surface to the lower rotor blade tip would be between 30 m to 50 m for wind farm projects in Zones 1 and 2 and 50 m for wind farm projects in Zones 3 to 5.

Within the framework of StUKplus, the flight height distribution of a total of seven species of seabirds and resting birds was determined using rangefinders in the "TESTBIRD" project. The great black-backed, herring and great black-backed gulls flew at heights of 30-150 m in the majority of the flights recorded. In contrast, species such as Kittiwake, Common Gull, Lesser Black-backed Gull and Gannet were mainly observed at lower altitudes up to 30 m (MENDEL et al. 2015). A recent study at the Thanet Offshore Wind Farm in England also investigated the flight height distribution of gannets, kittiwakes and the great black-backed gulls Herring Gull, Lesser Black-backed Gull and Lesser Black-backed Gull using a rangefinder (SKOV et al. 2018). The flight height measurements of Great Black-backed Gulls and Gannets were comparable to the heights determined by Mendel et al. (2015). Kittiwakes, on the other hand, were mostly observed at an altitude of about 33 m.

In general, large and small gulls have a high manoeuvrability and can react to wind turbines with appropriate evasive manoeuvres (GARTHE & HÜPPOP 2004). This was also shown in the study by SKOV et al. (2018), in which not only the flight altitude but also the immediate, small-scale and large-scale evasive behaviour of the species considered was investigated. Furthermore, the investigations using radar and thermal imaging cameras revealed a low level of nocturnal activity, resulting in only low collision risks for the relevant species at night.

The terns listed in Annex I of the V-RL are extremely agile flyers and prefer low flight altitudes (GARTHE & HÜPPOP 2004). Therefore, only low collision risks can be assumed for these species in general.

During the operational phase of the wind farms, species sensitive to disturbance can be expected to avoid the wind farm areas to a species- and area-specific extent.

Red-throated and black-throated divers show strong avoidance behaviour towards offshore wind farms. From the wind farm projects in area EN5, current results from ongoing operational monitoring show significant mean avoidance distances up to at least 10 km (BIOCONSULT SH 2017, BIOCONSULT SH 2018, BioConsult SH 2019, BIOCONSULT SH 2020) or approx. 15 km (IFAÖ 2018). For the wind farm projects in area EN4, effects on diver distribution could be demonstrated up to 10 km from the wind farm (IBL UMWELTPLANUNG et al. 2017a, IBL UMWELTPLANUNG ET AL. 2018, IBL UMWELTPLANUNG ET AL. 2019). For areas EN1 to EN3, effects were detected up to 2 - 4 km (IFAÖ et al. 2017). A recent study by the FTZ on behalf of the BSH and the BfN, which took into account data from wind farm monitoring in the EEZ as well as research data and data from Natura2000 monitoring, found a statistically significant decrease in diver abundance up to 10 km, starting from the periphery of a wind farm, across all built-up areas in the EEZ (GARTHE et al. 2018). This was also the conclusion of a study commissioned by the BWO, which used a modified data basis and different statistical analysis methods compared to the FTZ study (BIOCONSULT SH et al. 2020). The DIVER research project used an independent method to determine avoidance effects by transmitting (telemetry) divers in the German EEZ in addition to the usual digital aircraft-based recording of seabirds and resting birds. Significant avoidance effects up to a distance class of 10 - 15 km also emerge from the telemetric surveys of the DIVER research project from the area of wind farms in areas EN4 and EN5 (BURGER et al. 2018). The large-scale digital surveys carried out as part of the HELBIRD research project west of Sylt revealed statistically significant avoidance effects up to a distance of 16.5 km from a wind farm, whereby the increase in diver density with increasing distance from the wind farm was strongest within 10 km (MENDEL et al. 2019). It should be noted that these distances do not represent total avoidance, but rather partial avoidance with increasing diver densities up to the corresponding distances from a wind farm. Common to all studies is the observation that divers avoid the actual wind farm area (footprint).

For the quantification of habitat loss, a shooing distance of 2 km (defined as a complete avoidance of the wind farm area including a buffer zone of 2 km) for divers was still used as a basis in early decisions on individual approval procedures. 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 current study by GARTHE et al. (2018) shows more than a doubling of the shooing distance to an average of 5.5 km. This shy distance, or calculated complete habitat loss, is subject to the purely statistical assumption that no divers occur up to a distance of 5.5 km from an offshore wind farm. The study commissioned by the BWO resulted in a theoretical habitat loss of 5 km for wind farm projects in the entire study area considered and thus provided a comparable result. In the individual analysis of a northern and a southern sub-area, regional differences were indicated with a theoretical complete habitat loss of 2 km in the southern sub-area. However, for wind farm projects in the northern sub-area, which includes the main concentration area, the calculated overriding value of 5 km was confirmed (BIOCONSULT SH et al. 2020).

All available results from research and monitoring consistently show that the divers' avoidance behaviour towards wind farms is far more pronounced than previously assumed.

For other species such as gannets, razorbills, lesser black-backed gulls and fulmars, there are findings on small-scale or partial avoidance behaviour towards wind farms (e.g. DIERSCHKE et al. 2016, SKOV ET AL. 2018, IFAÖ ET AL. 2017, IBL UMWELTPLANUNG ET AL. 2017a, IBL UMWELTPLANUNG ET AL. 2018).

For the common guillemot, which is widespread in the German North Sea, previous findings indicate that reactions to offshore wind farms depend on various factors. DIERSCHKE et al. (2016) compiled findings on the behaviour of seabirds from 20 European wind farms. The studies considered showed that guillemots appear to react differently depending on the location of an offshore wind farm. In the wind farms considered, complete avoidance of the OWP area, partial avoidance behaviour into adjacent areas or no avoidance behaviour at all was observed (DIERSCHKE et al. 2016). The authors attribute these differences to food availability at the respective site. MENDEL et al. (2018) add a seasonal aspect to the avoidance behaviour of guillemots. Using digital flight transect surveys in the area north of Helgoland, the authors found differences in avoidance behaviour before and during the breeding season. Thus, in spring, a significant reduction in density was found up to within 9 km of wind farm projects north of Helgoland, while no effect radius was found during the breeding season. MENDEL et al. (2018) relate these differences to the reduced action radius and attachment to the breeding colony on Helgoland during the breeding season. In spring, however, Common Guillemots are independent of a specific action radius and generally show a more westerly distribution (MENDEL et al. 2018). In a recent study, PESCHKO et al. (2020) confirmed the behaviour of MENDEL et al. (2018) during the breeding season by using transmittered guillemots in the same study area. From the monitoring of wind farm projects in the German EEZ, there are currently indications of partial avoidance effects up to 6 km from area EN8 (IBL et al. 2018). However, these results take into account studies from a complete annual cycle and are not broken down seasonally. There is currently no scientific evidence on seasonal and site-specific avoidance behaviour during the high occurrence seasons of winter and autumn.

It can also be assumed that the fish stocks will recover during the operational phase due to a regular ban on fishing within the wind farms, which is accompanied by a prohibition of navigation for ships. In addition to the introduction of hard substrate, the species spectrum of the fish present could thus increase and offer an attractive food supply for foraging seabirds.

If the ROP is not implemented, the planning of wind farm projects would be less spatially coordinated. This would probably increase the amount of land taken up, which in turn could have an impact on species sensitive to disturbance. Furthermore, the ROP is based on planning principles that provide not only for spatial but also temporal coordination of construction projects in order to reduce temporary factors affecting seabirds and resting birds, such as additional construction-related shipping traffic.

Even though similar factors would basically affect the protected species of seabirds and resting birds both if the ROP were implemented and if it were not, the protection of seabirds and resting birds would be more difficult to ensure if it were not implemented due to the lack of planning principles and their coordinating requirements.

3.2.6 Migratory birds

Construction-related: During the construction phase, impacts are primarily caused by light emissions and visual disturbance. These can cause scaring and barrier effects on migrating birds to varying degrees depending on the species. However, the illumination of construction equipment can also lead to attraction effects for migrating birds and increase the risk of collision.

Installation and operational: Possible impacts of offshore wind farms during the operational phase may be that they constitute a barrier for migrating birds or a collision risk. Flying around them or otherwise disturbing their flight behaviour can lead to higher energy consumption, which can affect the birds' fitness and subsequently their survival rate or breeding success. Bird strike events may occur on vertical structures (such as rotors and support structures of wind turbines, substations and converter platforms). Poor weather conditions - especially at night and in strong winds - and high migration intensities increase the risk of bird strikes. In addition, there are possible glare or attraction effects caused by the safety lighting of the installations, which can lead to birds becoming disoriented. Furthermore, birds caught in wake currents and air turbulence at the rotors could be impaired in their manoeuvrability. However, for the aforementioned factors, as well as for the scaring and barrier effects, it can be assumed that the sensitivities and risks are different for each species.

As a general rule, a threat to bird migration does not already exist if there is an abstract danger that individual birds will be harmed during their passage through an offshore wind farm. A threat to bird migration only exists if sufficient knowledge justifies the prognosis that the number of potentially affected birds is so large that, taking into account their respective population size, a significant impairment of individual or several different populations can be assumed with a sufficient degree of probability. The biogeographical population of the respective migratory bird species is the reference for the quantitative assessment.

There is agreement that, under the existing legal situation, individual losses of individuals during bird migration must be accepted. In particular, it must be taken into account that bird migration in itself poses many dangers and subjects populations to harsh selection. The mortality rate can be around 60 to 80 % for small birds, while the natural mortality rate is lower for larger species. Also, different species have different reproductive rates, so the loss of individuals can be of different consequence for each species.

Due to a lack of sufficient knowledge, it has not yet been possible to determine a generally valid acceptance threshold.

The corresponding height parameters of the turbines are an important indicator for estimating the potential collision risk for migratory birds with offshore wind turbines. In the ROP, bandwidths for the height parameters of currently installed or potential turbine types were included in accordance with the current technical developments of wind turbines (cf. Chapter 4.2). Here, on the one hand, wind farm projects are taken into account that are already in operation, as well as those that will go into operation in the transitional system and the first commissioning years of the central system in zones 1 and 2. Another turbine spectrum represents turbines that could potentially be installed in future wind farm projects in zones 3 to 5. For already realised or future wind farm projects in Zones 1 and 2, data or assumptions are available for 5 to 12 MW turbines with a hub height of 100 to 160 m and, based on rotor diameters of 140 m to 220 m, a total height of 170 m to 270 m. For wind farm projects in Zones 3 and 5, data or assumptions are available for 5 to 12 MW turbines with a hub height of 100 to 160 m and, based on rotor diameters of 140 m to 220 m, a total height of 170 m to 270 m. For wind farm projects in Zones 3 to 5, assumptions are made for 12 to 20 MW turbines, which have a hub height of 160 to 200 m and, based on rotor diameters of 220 m to 300 m, a total height of 270 m to 350 m. This means that the lower rotor-free height is between 100 m and 350 m. The lower rotor-free height is between 170 m and 350 m. This means that the lower rotor-free area from the water surface to the lower rotor blade tip would be between 30 m to 50 m for wind farm projects in Zones 1 and 2 and 50 m for wind farm projects in Zones 3 to 5.

Altitude profiles obtained via migration plan observations in areas EN1 to EN3 show a strong concentration on altitude ranges up to 20 m and thus below the rotor range of the turbines shown above. While 85 % of the birds observed migrated in this height range in spring, almost three quarters did so in autumn (AVITEC RESEARCH 2017). The majority (92%) of the visible diurnal migration in area EN5 took place at flight altitudes below 20m. Overall, the proportion of flight movements in the potential risk area of the rotors (20 - 200 m) was 8.0 %. In the case of divers, geese and songbirds, more than one third of the individuals were registered in the potential risk area of the rotors (BIOCONSULT SH 2017).

Previous studies of bird migration using vertical radar in the EEZ in the North Sea showed that there was a diurnal dependency in the altitude distribution. During the day, bird migration in spring was concentrated at lower altitudes, as more than half of all radar echoes recorded during daylight were at altitudes up to 300 metres. If the number of bird echoes recorded during the day decreased continuously with increasing altitude, a bimodal distribution pattern to the recorded bird movements emerged in the dark. On the one hand, the lowest altitude ranges up to 100 m (35,018 flight movements; 13.2 %) and on the other hand the highest ranges between 900-1,000 m (30,295 flight movements; 11.4 %) were most heavily flown at night. About one third of the echoes each were recorded at altitudes up to 300 m, above 300 m to 700 m and above 700 m to 1,000 m (AVITEC RESEARCH 2017). Corresponding to the conditions in spring, however, bird migration nights were also recorded in autumn with altitude profiles that deviated from the basic pattern. On the strong bird migration night of 25/26 October, the altitude range above 900 m to 1,000 m was the most heavily flown, suggesting that bird migration was underestimated on this night and that a high (but unknown) proportion of migrating birds flew over the radar measurement range. Also on the very strong bird migration night 09/10/11, bird migration was comparatively strongly shifted upwards. Avitec Research (2017) therefore assumes that their vertical radar system with its considered data basis registers at least 2/3 of the total bird migration up to an altitude of 1,000 m on average. In individual cases, the recorded proportion can be significantly higher during strong bird migration, depending on the vertical wind profile. Conversely, more than half of all migratory birds will be missed on nights when the altitude distribution decreases or even increases slowly with altitude. However, this is usually only the case on a small number of nights.

Migrating birds generally fly higher in good weather than in bad weather. In addition, most birds usually start their migration in good weather and are able to choose their departure conditions so that they are reasonably likely to reach their destination in the best possible weather. In the clear weather conditions preferred by birds for their migration, the probability of a collision with wind turbines is therefore low because the flight altitude of most birds will be above the range of the rotor blades and the turbines are clearly visible. On the other hand, unexpected fog and rain, which lead to poor visibility and low flight altitudes, pose a potential hazard. The coincidence of bad weather with so-called mass migration events is particularly problematic. According to information from various environmental impact studies, mass migration events, in which birds of various species fly over the North Sea at the same time, occur about 5 to 10 times a year. An analysis of all existing bird migration studies from the mandatory monitoring of offshore wind farms in the EEZ of the North Sea and Baltic Sea (observation period 2008 - 2016) confirms that particularly intensive bird migration coincides with extremely bad weather conditions at less than 1 % of the migration times (WELCKER 2019b).

In addition to the risk to bird migration from bird strikes, another risk for migrating birds is that the migration route could be diverted and thus extended by the presence of wind turbines. However, this does not affect bird migration in its entirety, as a large part of the migration takes place at altitudes outside the sphere of influence of wind turbines. Many songbirds, for example, migrate at altitudes between 1,000 and 2,000 metres. Waders are also known to migrate at very high altitudes (JELLMANN 1989). However, significant numbers migrate at altitudes <200 m and thus within the range of influence of wind turbines. Many of the low-migrating species belong to the group of waterbirds and seabirds that are able to land on the water to rest and possibly feed. For species like these, any detours will therefore have little impact. It could be problematic for migratory land birds that are not capable of landing on the water. It should be noted that migratory birds are capable of impressive non-stop flight performances, especially when migrating non-aquatic species over seas. The non-stop flight performance of many species, including small birds, is over 1,000 km (TULP et al. 1994). It is therefore not to be expected that the possibly required additional energy demand due to a diversion necessary in the EEZ of the North Sea, provided that no contiguous cross-bars are created in the main direction of migration, would lead to a threat to bird migration.

If the ROP were not implemented, the planning of wind farm projects would be less spatially coordinated. This would probably increase the amount of land taken up. Furthermore, the ROP is based on planning principles that provide for both spatial and temporal coordination of construction projects.

Even though similar factors would basically affect migratory birds both if the ROP were implemented and if it were not, it would be more difficult to ensure the protection of migratory birds if it were not implemented due to the lack of planning principles and their coordinating requirements.

3.2.7 Bats and bat migration

At present, there are no reliable findings on possible migration corridors and migration behaviour of bats over the North Sea. In general, the following effects of the use of offshore wind energy can have an impact on bats:

Construction-related: Construction activities during the erection of WTGs are associated with increased vessel traffic. The illumination of the ships and the construction site can cause attraction effects on bats migrating across the sea. The risk of collision with the ships and the construction site would then be possible.

Installation- and operation-related: During the operational phase, the lighting of the installations may possibly cause attraction effects that could lead to collisions.

If the plan is not implemented, the same impacts on bats may occur as if the plan were implemented.

3.2.8 Air

The construction and operation of the wind turbines and platforms as well as the laying of submarine cable systems will increase shipping traffic. However, there are no measurable impacts on air quality. Therefore, the air quality will develop in the same way if the plan is implemented as if it is not implemented.

3.2.9 Climate

Negative impacts on the climate from offshore wind energy are not expected, as no measurable climate-relevant emissions occur either during construction or operation. The CO_2 savings associated with the expansion of offshore wind energy (cf. Chapter 1.8) can be expected to have a positive impact on the climate in the long term.

3.2.10 Landscape

The realisation of offshore wind farms has an impact on the landscape, as it is altered by the erection of vertical structures. The turbines also have to be fired at night or in poor visibility for safety reasons. This can also have a visual impact on the landscape. The erection of platforms can also lead to visual changes in the landscape. The extent to which the landscape is affected by offshore installations depends strongly on the respective visibility conditions, but also on subjective perceptions and the basic attitude of the observer towards offshore wind energy. The vertical structures, which are untypical for the usual image of a seascape, can be perceived partly as disturbing, but also partly as technically interesting. In any case, they cause a change in the landscape and the character of the area is modified. The actual visibility is determined by the distance of the offshore wind farms from the coast or islands, the size of the wind farm in terms of area, the height of the WTs, the visibility based on the specific weather conditions, the height of the viewer's location (e.g. beach, viewing platform, lighthouse) and the capacity of the human eye. Due to the considerable distance (more than 30 km) of the planned and already reached WTs and platforms from the coast, the turbines will only be perceptible from land to a very limited extent, and only under good visibility conditions. This also applies with regard to the night-time security lights.

Minimising visibility is helped by the fact that, as part of the approval of individual projects, a glare-free and low-reflection coating is made a standard requirement. In addition, it must be taken into account that the platforms are always planned in spatial proximity or in spatial association with the offshore wind farms, so that the change to the landscape caused by these individual structures in direct spatial proximity to the offshore wind farms is only slightly increased.

Overall, the impairment of the landscape by offshore installations from the coast can be classified as quite low.

The development of the landscape in the case of non-implementation of the ROP is not expected to differ significantly from the development in the case of implementation of the ROP. However, it should be noted that the required land use can be minimised by the provisions of the ROP (and the land use development plan). The potential impacts on the landscape as a protected resource can thus be reduced to a minimum through spatially coordinated, forward-looking and coordinated overall planning of the ROP and the FEP. Insufficient spatial coordination in the event of non-implementation of the plan could lead to more fragmented wind farm areas and greater land take and slightly increased visibility from the coast.

For the submarine cable systems, negative impacts on the landscape during the operational phase can be ruled out due to the laying as underwater cables.

3.2.11 Cultural assets and other material assets

During the deep foundation of the wind turbines, the seabed is disturbed due to construction, which can affect discovered and undiscovered cultural heritage. The cultural heritage will be completely or partially destroyed or its context affected during excavation or pile driving. In addition, extensive secondary impacts on the underwater cultural heritage property from construction vehicles are to be expected during construction work.

Due to the foundation acting as a flow obstacle, the long-term formation of scouring funnels is to be expected, especially on fine-sand seabeds, whereby cultural traces that remained undiscovered during the construction measures can erode freely.

3.3 Lines

Lines within the meaning of the maritime spatial plan include pipelines and submarine cables. Submarine cables include cross-border power lines and connection lines for offshore wind farms as well as data cables. So-called internal submarine cables are not included in this definition. Reference is made to the specifications within the framework of the technical planning (FEP) in this regard.

Pipelines that merely cross the German continental shelf (so-called transit pipelines) and those that also land on the German coast run through the North Sea EEZ. The Norpipe, Europipe 1 and Europipe 2 pipelines transport natural gas from the Norwegian gas fields to Germany. These pipelines land on the coast of Lower Saxony. Since 2009, a gas pipeline has been added in the Duck's Bill area between the Danish Ravn oil field and the German A6-A production platform. No further pipelines are currently planned.

The reserved areas for power lines serve to secure routes for existing and future pipelines and submarine cables. Cables carrying electricity are the subject of specialist planning.

Nine submarine cable systems are currently in operation in the North Sea EEZ to connect offshore wind farms. Five more systems are currently under construction.

In the North Sea, grid connection systems are operated with direct current and alternating current. The wind turbines produce alternating current, which is collected on the wind farm's own transformer platforms and transformed up to a voltage level of 155 kV. The electricity is then transmitted from the transformer platform via an AC cable (alternating current) to the converter platform of the transmission grid operator. Alternatively, the direct connection of the wind turbines to the converter platform will be implemented in future by means of a 66 kV submarine cable system to the converter platform. The 66 kV direct connection was defined as the standard connection concept in the FEP 2019.

In comparison, DC transmission technology represents a more area-efficient technology due to the significantly higher transmission power compared to AC technology, combined with lower environmental impacts due to cable laying.

In addition, three transnational power cables - NorNed, Nord.Link and COBRAcable - are currently in operation in the North Sea EEZ. Transnational data cables - usually fibre optic cables for telecommunications - cross the German North Sea in large numbers. In addition, there are also quite a number of decommissioned cables in the seabed that were not removed after they ceased to be used.

Pipelines have different impacts on the marine environment. Power lines primarily affect the protected resources of soil, benthos and fish; here, the potential impacts due to the introduction of hard substrate, turbidity plumes and, for current-carrying cables, operation-related heat emissions and, where applicable, magnetic fields are assessed.

For the assessment of the determinations for pipelines, the following possible impacts are examined:

Table 20: Potential impacts of power lines on the marine environment (t = temporary).

Use	Effect	Potential impact	Protected goods																
			Benthos	Fish	Seabirds and	Migratory birds	Marine mammals	Bats	Plankton	Biotope types	Biodiversity	Floor	Area	Water	Air	Climate	Man/ Health	Cultural and mate-	Landscape
Lines Routes for submarine cable systems and pipelines	Placement of hard substrate (riprap)	Habitat modification	x	x					x	x		x						x	
		Habitat and land loss	x	x						x		x	x					x	
	Heat emissions (live cables)	Impairment/displacement of cold-water-loving species	x								x	x							
	Magnetic fields (live cables)	Impairment	x																
		Impairment of the orientation behaviour of individual migratory species		x															
	Turbidity plumes (construction phase)	Impairment	x t	x t	x t				x t					x t					
		Physiological effects and chilling effects		x t															

3.3.1 Floor

Pipelines

During installation in the seabed, the formation of a near-bottom turbidity plume and small-scale changes in morphology and sediment association are likely. The resuspended sediments are transported and deposited in the vicinity of the pipeline at different distances depending on the grain size: The distances are significantly below those observed for the sedimentation of turbidity plumes in the course of sand and gravel extraction. The concentrations of resuspended particulate material are of a comparable order of magnitude to natural resuspension of sediments caused by storms.

The formation of undercutting ("freespans") can lead to a change in sediment properties or grain composition, which is, however, spatially limited. Depending on the sand supply and geological structure of the subsoil, these undercutting processes can stabilise or only occur temporarily. In the case of sand deficits, a change in the substrate may occur, e.g. boulder clay, clover or similar material temporarily accumulating on the seabed.

To protect the pipeline from external corrosion, sacrificial anodes made of zinc and aluminium are attached at regular intervals; these are only dissolved in small quantities and released into the water column. Due to the very high dilution, they are only present in trace concentrations; in the water, they are adsorbed to sinking or resuspended sediment particles and sediment on the seabed.

Submarine cable

When laying submarine cables, there are generally changes to the bottom morphology and the original sediment structure in the route area as a result of the cable laying. However, due to the natural sediment dynamics in the North Sea, the seabed along the affected routes can regenerate.

In addition to the formation of a near-bottom turbidity plume, there may be resuspension of sediment-bound pollutants and increased pollutant input from construction site traffic.

Magnetic effects during the operation of current-carrying cables can be neglected or excluded because the magnetic fields of AC cables (three-wire three-phase cables) and bipolar DC cables almost cancel each other out. Depending on the duration and strength of the wind speed, energy losses occur during the power transmission to the onshore grid, which subsequently lead to a heating of the sediment around the cable. According to the state of the art, oil-insulated cables are not used. Lead cannot leak through the insulation.

Due to the operating conditions, the surrounding sediment heats up radially around the cable systems in both direct current and three-phase submarine cable systems. The heat emission results from the thermal losses of the cable system during energy transmission.

These energy losses depend on a number of factors. The following output parameters have a significant influence:

- Transmission technology: In principle, for the same transmission power, three-phase submarine cable systems can be expected to emit more heat through thermal losses than direct current submarine cable systems (OSPAR Commission 2010).
- Ambient temperature in the area of the cable systems: Depending on the water depth and season, a range of fluctuation in the natural sediment temperature can be assumed, which has an influence on heat dissipation.
- Thermal resistance of the sediment:In the EEZ, predominantly water-saturated sands occur, for whose specific thermal resistance a range of 0.4 to 0.7 KmW-1 is valid, taking into account various sources (Smolczyk 2001, Bartnikas & Srivastava 1999, VDI

1991, Barnes 1977). According to this, a more efficient heat dissipation can be assumed for water-saturated coarse sands than for finer-grained sands.

The installation depth of the cable systems is also decisive for the temperature development in the sediment layer near the surface. According to current knowledge, no significant impacts from cable-induced sediment heating are to be expected if a sufficient installation depth is maintained and state-of-the-art cable configurations are used. Within the framework of the environmental expert contributions for downstream cable systems of offshore wind farms, various calculations on sediment heating due to the operation of submarine cable systems were submitted. According to the applicant, the cable-induced sediment heating at the project "BorWin 3 and BorWin gamma" will amount to approx. 1.3 K in 20 cm sediment depth for the DC cables if the cables are washed in at a depth of at least 1.50 m, as specified in the FEP (PRYSMIAN, 2016). Temperature measurements on a park-internal three-phase cable system in the Danish offshore wind farm "Nysted" showed a sediment heating directly above the cable (transmission power of 166 MW) 20 cm below the seabed of max. 1.4 K (MEISSNER et al. 2007). The intensive near-bottom water movement in the North Sea also leads to a rapid removal of local heat.

Taking into account the above-mentioned results and forecasts, it can be assumed that at a laying depth of at least 1.50 m, compliance with the so-called "2 K criterion"[10] can be assumed, which has become established as a precautionary value in current official approval practice. In order to ensure compliance with the "2 K criterion", i.e. a maximum temperature increase of 2 degrees in 20 cm below the seabed surface, a corresponding principle on sediment heating has already been included in the BFO-N and continued in the FEP (cf. e.g. Planning Principles 5.3.1 and 5.3.2). Planning principles 5.3.2.9, 5.4.2.9, 5.5.2.13 BFO-N and planning principle 4.4.4.8).

This principle stipulates compliance with the 2 K criterion in order to reduce as far as possible potential adverse effects on the marine environment caused by cable-induced sediment heating. If the 2C criterion is complied with in accordance with the planning principle, it can currently be assumed that no significant impacts, such as structural and functional changes, are to be expected on the soil as a protected resource as a result of the cable-induced sediment heating. Due to the low proportion of organic material in the sediment, the sediment heating is not expected to result in any significant release of pollutants.

The above-mentioned impacts on soil as a protected resource occur independently of the ROP specifications. However, if the plan were not implemented, a spatially less coordinated planning of the pipeline systems would have to be expected. This would result in an increased number of pipeline crossings or crossing structures, which would require the placement of hard substrate.

As the provisions of the plan aim to minimise the impact on the seabed/sensitive areas through the predominant location outside sensitive areas and the reduction of pipeline routes, it would probably be more difficult to ensure the protection of the seabed if the plan were not implemented than if it were.

[10] "The so-called 2 C criterion represents a precautionary value which, according to the BfN's assessment based on the current state of knowledge, ensures with sufficient probability that significant negative impacts of cable heating on nature or the benthic community are avoided." (http://www.stromeffizienz.de/page/fileadmin/offshore/documents/StAOWind_Workshops/Kabel_in_Schutzgebieten/Kabel_in_Schutzgebieten_Vortrag_Merck.pdf)

3.3.2 Benthos and biotope types

With regard to benthos and biotopes, the statements in Chapter 3.2.2apply analogously. If the plan were not implemented, a spatially less coordinated planning of pipelines would have to be expected. Most of the reserved areas for pipelines run outside sensitive protected areas. In addition, an increased number of pipeline crossings or crossing structures would have to be expected, which would also require the introduction of hard substrate. Here, too, the habitat structures would change on a small scale, which in turn could lead to a shift or change in the species spectrum of the benthos.

As the provisions of the plan aim to minimise the impact on the seabed/sensitive areas through the predominant location outside sensitive areas and the reduction of pipeline routes, the protection of benthos and biotopes would probably be more difficult to ensure if the plan were not implemented than if it were.

3.3.3 Fish

Pipelines

During the construction phase of pipelines, fish fauna can be temporarily scared away by **noise and vibrations caused by the** use of ships and cranes as well as by the installation of the pipeline systems (see also chapter 3.2.3). Furthermore, construction-related **turbidity plumes** can occur near the bottom and local sediment shifting can take place, which can harm fish, especially spawn and larvae. The ecological effects of turbidity plumes on fish are described in detail in Chapter 3.4.3 The effects on fish in the areas with sediment redistribution are short-term and spatially limited.

Submarine cable

The construction-related adverse effects on fish fauna from submarine cables, as well as from pipelines, are to be expected from **sound emissions and turbidity plumes.** Detailed information can be found in chapters 3.2.3and 3.4.3

Due to the rock fills in the area of the planned pipeline crossings, a **local change in the fish community is** to be expected. A change in the fish community may lead to a change in the dominance ratios and the food web. However, due to the small scale of the planned cable crossing structures, these effects are to be considered minor.

With regard to the possible operational impacts of the submarine cable systems of OWPs, such as **sediment heating and electromagnetic fields,** no significant impacts on fish fauna are to be expected either. Experience shows that sediment heating in the immediate vicinity of the cables will not exceed the precautionary value of 2K at a sediment depth of 20 cm. Direct electric fields do not occur with the planned cable type due to the shielding. Induced magnetic fields of the individual conductors cancel each other out to a large extent with the planned bundled laying with one outgoing and one return conductor and are significantly below the strength of the natural earth's magnetic field. According to TdV, the magnetic field generated during operation of the Ostwind 2 cable system amounts to a maximum of 20 μT at the seabed surface. In comparison, the natural earth's magnetic field is 30 to 60 μT, depending on the location. The field strength decreases rapidly with increasing distance from the cable. Especially diadromous species, such as salmon and European eel, could react sensitively to electromagnetic fields. However, various studies on the effects of electromagnetic fields on the European eel showed no clear results. In the Danish wind farm "Nysted", no behavioural changes of the eel could be recorded (BIO/CONSULT AS 2004). On the other hand, both WESTERBERG AND LAGENFELT (2008) and GILL AND BARTLETT (2010) recorded short-term changes in their swimming activity. Overall, due to the expected moderate and small-scale change in the magnetic field in the area of the cable, a blockage of the migratory movements of marine fish is unlikely. However, magnetosensitive fish species might avoid the immediate area of the cable.

In the case of the three-wire three-phase cables and bipolar direct current cables planned for the German EEZ, magnetic effects during operation can be neglected or excluded, as the magnetic fields almost cancel each other out. Significant impacts on sensitive fish species are therefore not to be expected.

The objectives and principles for pipelines in the ROP take into account the gentlest possible laying methods, the bundling of pipelines and optimised routing. The impacts on fish fauna are thus likely to be minimised, which would not be the case if the plan were not implemented.

3.3.4 Marine mammals

Pipelines

Marine mammals may be affected during the laying, operation, maintenance and dismantling of pipelines in the sea. These include: Vessel traffic, noise emissions, sediment plumes and pollution. During normal operation, impacts on marine mammals can almost certainly be ruled out. During maintenance work, increased shipping traffic with noise emissions and pollution is possible.

Construction-related: During the laying of pipelines, temporary noise pollution and sediment turbidity plumes occur. The intensity and duration of sound emissions depend mainly on the installation method. Overall, however, disturbances to marine mammals caused by pipe-laying work are small-scale, local and of short duration.

Impacts due to alteration of sediment structure and damage to benthos during installation are in any case negligible for marine mammals. These changes occur on a small scale along the pipeline. Impacts due to long-term changes in sediment structure and benthos are insignificant for marine mammals, as they predominantly forage for prey organisms in the water column in widespread areas.

Direct disturbance of marine mammals at the individual level may occur during the laying and dismantling of pipelines. Impacts from shipping traffic and, in particular, from noise emissions during pipe-laying work are only to be expected on a regional and temporary basis. The formation of sediment plumes is largely expected to be local and temporary. Overall, a loss of habitat for marine mammals at the individual level could only occur locally and for a limited period of time.

Operational: The pipelines laid on the seabed can cause attraction effects on marine mammals, triggered by increased fish occurrence in the area of the pipelines (these in turn can be attracted by benthic organisms settling on the pipelines).

During normal operation, pipelines have no significant impact on marine mammals. In the event of damage to the pipeline or inspection and maintenance work, regional and temporal disturbances due to shipping traffic with noise emissions and pollutant leakage are possible.

Impacts from sediment and benthic changes are insignificant for marine mammals, as they predominantly forage for prey organisms in the water column in widespread areas. Should the benthic species spectrum change along pipelines laid on the seabed, the change would possibly attract fish more strongly. Increased fish abundance could in turn also attract marine mammals.

During normal operation, impacts on the population level are not known. Due to the narrow, linear course of pipelines, negative impacts on the population level can be excluded with certainty.

Non-implementation of the plan would not affect the existing or described impacts of pipelines on harbour porpoise, harbour seal and grey seal.

Submarine cable

Potential impacts on marine mammals during the laying and, in some cases, dismantling of submarine cables are: Shipping traffic, noise emissions and turbidity plumes. Potential operational impacts on marine mammals from the generation of electric and magnetic fields in the immediate vicinity of submarine cables depend on the type of cable.

Construction-related: During the laying of cables, noise emissions occur for a limited period of time, which can potentially cause disturbance to marine mammals. The duration and intensity of sound emissions vary depending on the installation method. However, the effects of noise emissions during installation are local and temporary. The intensity of the impact can vary between medium and high depending on the installation method. This also applies to effects caused by the formation of turbidity plumes. Changes in sediment structure and associated temporary benthic changes have no impact on marine mammals. Marine mammals forage in extensive areas in the water column.

Operational: During operation, power cables can lead to heating of the surrounding sediments. However, this has no direct impact on highly mobile animals such as marine mammals.

Overall, no significant impacts are expected from cables used to dissipate energy or from bundling cables in a common route on marine mammals either at individual or population level.

Non-implementation of the plan would not affect the existing or described impacts of submarine cables on harbour porpoise, harbour seals and grey seals.

3.3.5 Seabirds and resting birds

Pipelines

Construction-related*:* During the laying of pipelines, temporary sediment turbidity plumes and local sediment and benthic changes occur. During the laying work, construction-related shipping traffic can cause visual disturbance and trigger shying or avoidance reactions in species sensitive to disturbance.

Overall, potential construction-related impacts are only temporary and local for the duration and immediate area of the relocation.

Operational: Impacts due to sediment and benthic changes are of minor importance for seabirds and resting birds, as they forage for prey organisms mainly in the water column in widespread areas. If the benthic species spectrum were to change along pipelines laid on the seabed, the change would possibly attract fish more strongly. Increased fish abundance could in turn also attract seabirds. During the operational phase, maintenance-related vessel traffic may cause visual disturbance and trigger temporary shying or avoidance reactions in species sensitive to disturbance.

Submarine cable

Construction-related*:* During the laying of submarine cables, temporary sediment turbidity plumes and local sediment and benthic changes occur. During the laying work, construction-related shipping traffic can cause visual disturbance and trigger shying or avoidance reactions in species sensitive to disturbance.

Overall, potential construction-related impacts are only temporary and local for the duration and immediate area of the relocation.

Operational: Impacts due to sediment and benthic changes are of minor importance for seabirds and resting birds, as they mainly search for their prey organisms in the water column in extensive areas. During the operational phase, maintenance-related shipping traffic may cause visual disturbance and trigger temporary shying or avoidance reactions in species sensitive to disturbance.

If the plan were not implemented, there would be less spatial coordination in the planning of pipelines and border corridors. The ROP is based on planning principles that provide for spatial as well as temporal coordination of construction projects in order to minimise impacts on, among others, the marine environment and thus also seabirds and resting birds.

Even if, in principle, similar factors would have an effect on the protected species of seabirds and resting birds both if the ROP were implemented and if it were not implemented, it would be more difficult to ensure the protection of the marine environment and thus of seabirds and resting birds if it were not implemented, due to the lack of planning principles and their coordinating requirements.

3.3.6 Migratory birds

Pipelines

Potential impacts of pipelines on migratory birds are mainly limited to the construction phase. Illuminated construction vehicles can cause attraction effects, which can lead to collisions.

Submarine cable

Potential impacts of pipelines on migratory birds are mainly limited to the construction phase. Illuminated construction vehicles can cause attraction effects, which can lead to collisions.

The potential impacts on bats occur regardless of whether the Plan is not implemented or is implemented.

3.3.7 Bats and bat migration

Potential impacts of power lines on bats are mainly limited to the construction phase. Illuminated construction vehicles can cause attraction effects, which can lead to collisions.

The potential impacts on bats occur regardless of whether the Plan is not implemented or is implemented.

3.3.8 Air

Pipelines

The laying, maintenance and dismantling of pipelines involves shipping traffic. This in turn leads to pollutant emissions that can affect air quality.

Significant adverse impacts on air quality are not expected.

Submarine cable

The laying, maintenance and dismantling of submarine cables involves shipping traffic. This in turn leads to pollutant emissions that can affect air quality. Significant adverse impacts on air quality are not expected.

3.3.9 Cultural assets and other material assets

Construction-related impacts from pipelines and submarine cables on underwater cultural heritage depend on the installation methods used. Both flushing and dredging can lead to the destruction of underwater cultural heritage on the seabed. In addition to the direct impacts of the installation methods used, indirect impacts, e.g. from anchor work or screw water, must also be considered.

For pipelines that are laid directly on the seabed and sink into the sediment over time, the direct impact can be considered minor. Installation- and operation-related impacts are not to be expected.

3.4 Raw material extraction

The extraction of raw materials from the sea takes place both for commercial purposes and - especially the extraction of stone, gravel and sand - for coastal protection. In addition, large areas, especially in the North Sea, were already occupied with permit fields for the exploration of hydrocarbons. In the German EEZ, these are primarily natural gas deposits. The importance is particularly evident for the North Sea; here, the production volumes at sea clearly exceed those on land.

The Federal Mining Act (BBergG) is the federal law regulating mining law issues and covers, among other things, the exploration and extraction of raw materials. The raw material safeguarding clause of sec. 48 para. 1 sentence 2 BBergG is intended to apply extra-mining regulations of other competent authorities in such a way that the exploration and extraction of raw materials are impaired as little as possible. Furthermore, the BBergG provides in sec. 48 ff. the BBergG also provides regulations for the benefit of shipping, fisheries, the laying and operation of cables and pipelines, and the marine environment, which must be observed when exploring for or approving operating plans for an operation in the area of the continental shelf.

Under Section 7 BBergG, permits grant the authorised permit holder the exclusive right to explore for mineral resources in a specific field. Under Section 8 BBergG, permits grant in particular the exclusive right to extract a raw material. The refusal of the permit or authorisation is based on the existence of the grounds specified in sec. 11 or sec. 12 BBergG.

Raw material extraction is regularly divided into different phases during implementation - exploration, development, operation and aftercare phases.

Exploration serves the exploration of raw material deposits according to sec. 4 para. 1 BBergG. In the marine area, it is carried out regularly by means of geophysical surveys, including seismic surveys and exploratory drilling. In the EEZ, the extraction of raw materials includes the extraction (dissolving, releasing), processing, storage and transport of raw materials.

For exploration in the area of the continental shelf, mining permits (permission, authorisation) must be obtained in accordance with the Federal Mining Act. These grant the right to explore for and/or extract mineral resources in a defined field for a specified period of time. Additional permits in the form of operating plans are required for development (extraction and exploration activities) (cf. Section 51 BBergG). For the establishment and management of an operation, main operating plans must be drawn up for a period not exceeding 2 years as a rule, and must be continuously renewed as required (sec. 52 para. 1 sentence 1 BBergG).

In the case of mining projects that require an EIA, the preparation of an outline operating plan is obligatory, for the approval of which a plan approval procedure must be carried out (Sec. 52 (2a) BBergG). As a rule, general operating plans are valid for a period of 10 to 30 years.

The construction and operation of production platforms for the extraction of crude oil and natural gas in the area of the continental shelf require an EIA in accordance with sec. 57c BBergG in conjunction with the Ordinance on the Environmental Impact Assessment of Mining Projects (UVP-V Bergbau). The same applies to marine sand and gravel extraction on extraction areas of more than 25 ha or in a designated nature conservation area or Natura 2000 site.

In the planning period 2004 to 2009, mining permits for sand and gravel extraction in the Sylt Outer Reef area were available for the North Sea:

Approval field	White bench	until 2039
Approval field	BSK 1	until 2033
Approval field	OAM III	until 2051

In these areas, between 0.8 and 2.4 million tonnes of sand and gravel were extracted annually from 1997 to 2006 under valid general operating plans.

Hydrocarbon exploration licences (NE3-0001-01, until the end of May 2020; B 20 008/71, until the end of May 2021) have been granted in the south-western EEZ and in the western EEZ (NE3-0002-01, until the end of December 2021).

The German North Sea A6/B4 permit (until 2028) exists for the extraction of natural gas in the "Entenschnabel" at the border to the Danish EEZ. At the time of planning, a production platform was in operation there, which ceased production in the second half of 2020.

Development of raw material extraction

In the period 2009 to 2019, there has been no approval of new permit or authorisation fields for sand and gravel mining or hydrocarbons in the German EEZ of the North Sea.

For the German EEZ in the North Sea, a decrease in the area of permit fields for hydrocarbons has been observed since the adoption of the regional planning plans in 2009.

All hydrocarbon permit fields in the Entenschnabel have expired, with the exception of the German North Sea permit A6/B4 with the A6-A production platform. The permit for mining in the Weiße Bank field has expired (ruling by the Higher Administrative Court of Schleswig, legally binding since 12 February 2019). No framework operating plan has been available for the BSK1 field since 2009.

The following table shows the effects of raw material extraction and potential impacts on the protected goods.

Table 21: Effects and potential effects of raw material extraction

Use	Effect	Potential impact	Protected goods																
			Benthos	Fish	Seabirds and resting birds	Migratory birds	Marine mammals	Bats	Plankton	Biotope types	Biodiversity	Floor	Area	Water	Air	Climate	Man/ Health	Cultural and material assets	Landscape
Raw materials Sand and gravel mining / Seismic surveys	Substrate removal	Habitat modification	x	x						x	x	x						x	
		Habitat and land loss	x	x						x	x	x	x					x	
	Turbidity plumes	Impairment	x t																
		Physiological effects and chilling effects		x t															
	Physical disorder	Impact on the seabed	x							x		x	x						
	Underwater sound during seismic surveys	Impairment / scare effect		x t			x t												

Potential temporary impacts result from underwater sound during seismic surveys and from turbidity plumes during resource extraction and may result in disturbance and scouring effects. Potential permanent impacts from substrate extraction and physical disturbance involve habitat and area loss, habitat modification and seabed disturbance.

3.4.1 Floor

Sand and gravel extraction

In the North Sea EEZ, gravel sands and sands are extracted in large areas using a suction trailer hopper dredger. In this process, a suction dredger with a trailing head usually 2 m wide passes over the extraction field several times for technical and navigational reasons until the maximum permissible extraction depth of 2 m plus a dredging tolerance of about half a metre is reached. As a rule, 2 to 4 m wide furrows of max. 2.6 m depth are created, between which unstressed seabed remains. A residual thickness of recoverable sediment must be preserved in order to maintain the original substrate for recolonisation.

Stone fields are excluded from extraction with a distance of 500 m. In the case of selective sediment extraction, the gravel sands are screened on board and the unused fraction (sand or gravel) is returned to site.

These sediment dredging operations affect the soil in many ways:

- Substrate removal and change in soil topography
- Change in hydrographic conditions
- Turbidity plume formation & sedimentation of suspended material
- Remobilisation of pollutants

Substrate removal and change as well as change in bottom topography: Due to the mining technique described above, the seabed is not lowered evenly by 2.6 m over the entire area, but a relief of multiple crossing furrows and original seabed is created. This topographical and morphological change affects the near-bottom current pattern. In principle, the original substrate should be preserved by surface mining, provided that the thickness of the sands, gravel sands and gravels that can be mined is sufficient. Selective extraction ("screening") results in a change of the substrate; depending on the recycled fraction, a refinement or coarsening of the original sediment type takes place. While the gravel fraction is locally stable and does not undergo any significant rearrangement, the recycled sand is mobilised by natural sediment dynamics. Due to the changed topography, a trap effect of the furrows occurs, in which redeposited, usually finer-grained sand accumulates and permanently changes the substrate (BOYD et al., 2004; ZEILER et al., 2004).

Formation of turbidity plumes and sedimentation of suspended material: Turbidity plumes occur at several points in the degradation process (HERRMANN and KRAUSE, 2000):

- Due to the mechanical disturbance of the sediment in the seabed by the dredge head
- The overflow water flowing back from the dredger into the sea
- The dumping of unwanted sediment fractions (screening).

The concentration of suspended material normally decreases very rapidly with distance (HERRMANN AND KRAUSE, 2000). Increased turbidity, however, is observed up to several hundred metres away from the dredger and can even be detected several kilometres away in individual cases. The extent of the turbidity plume depends on the grain size and quantity of the returned material as well as the current and its directional stability. Depending on grain size and water depth, a sorting of the refluxed grain mixture takes place: the coarse fractions are deposited first, which are mostly covered by the finer particles. In the further course, a progressive sorting occurs as the finer sands are increasingly redeposited by the natural sediment dynamics; the coarser sand fraction remains in the area of the backflow and undergoes less redeposition (ZEILER et al. 2004, DIESING, 2003). *Remobilisation of pollutants:* The resuspension of sediment particles can lead to the release of chemical compounds such as nutrients and heavy metals. This potential pollutant input is negligible because the commercially used sands and gravels usually have a low content of organic and clay components and thus show hardly any chemical interaction with the water column. In addition, the degradation activities are limited in time and space.

Currently, sand and gravel extraction is carried out within the framework of locally adapted conditions (ancillary provisions in the main operating plan) exclusively in the extraction area OAM III on a currently applied for extraction area of 17.5 km² (real area requirement 5.3 km²). With regard to the biotope type of "Species-rich gravel, coarse sand and shingle beds" occurring in this area, monitoring studies showed that the previous extraction activities have not led to a fundamental change in the sediment structure or composition in the extraction area. The original substrate in the area has been preserved and the results show occurrences of this protected biotope type in the same location within the extraction area (IFAÖ 2019a), which the BfN also confirms in its statement. . In the event of changes to the mining activities, the following must be ensured (OAM III Main Operating Plan,2019):

- Sufficient unmined areas remain between the excavation tracks so that the recolonisation potential with typical species-rich gravel, coarse sand and shingle grounds continues to be demonstrably given,

- the maximum permitted mining depth is demonstrably not exceeded,
- the original substrate, in this case coarse sand and gravel for species-rich gravel, coarse sand and shingle grounds, is demonstrably preserved.

With regard to the recording of changes in the original substrate, in the case of the BSKI and OAM III permit fields, the very variable small-scale occurrence of gravel and coarse sand areas as well as stones and boulders in the nature reserve "Sylt Outer Reef - Eastern German Bight" (see Chapter 2.1.1 and Figure 18) must be taken into account.

Based on the findings to date from the OAM III permit field, it can be summarised that the protection or preservation of original substrate and protected biotope types in the course of sand and gravel extraction is possible, among other things by means of locally adapted ancillary provisions and suitable monitoring studies.

Extraction of hydrocarbons

In the German EEZ, the production platform "A6-A" for the extraction of natural gas has been in operation since September 2000. The platform is located in 48 m water depth. It is a six-legged, truss-shaped steel construction with pile foundations (jacket construction).

According to the planning approval decision of the Upper Mining Authority Clausthal-Zellerfeld (now: LBEG - State Office for Mining, Energy and Geology) for the construction and operation of the A6-A drilling and production platform[11], the following impacts on the protected resource soil are to be expected:

Construction-related: Discharge of drill cuttings/drilling fluid may result in impacts due to load-induced compaction and material changes in the sediments. During the discharge of drill cuttings/drilling fluid, turbidity may occur for a limited period of time.

Installation-related: Impacts may occur in the form of foundation-related compaction of the seabed, pollution from coatings and changes in the flow conditions caused by the platform.

Operational: Corrosion coatings, sheathing materials, sacrificial anodes used for corrosion protection may release pollutants. The discharge of production water and waste water from the sewage treatment plant can lead to effects on the water and sediment.

In addition, long-term seabed subsidence of the order of several metres is to be expected as a consequence of the extraction of natural gas deposits, which has been described or predicted for Norwegian and Dutch oil and gas fields (Fluit and Hulscher, 2002; Mes, 1990; Sulak and Danielsen, 1989).

In addition to the current production in the KWN1 area, there are still the permit fields NE3-0002-01 on the border to the Dutch EEZ and the fields NE3-0001-01 and B 20 008/71 north of the Borkum Riffgrund. Within the permit fields, new permits for gas extraction are also expected to be issued in the future. By defining the KWN2-KWN5 reserved areas, areas for the construction of infrastructure associated with extraction are specified within the large-scale permit fields. In this way, the locations of production platforms, for example, can be better spatially controlled. Impacts on soil as a protected resource - as described above using the example of the A6-A extraction platform - can thus be controlled and minimised.

[11] Planning approval decision of the Upper Mining Authority for the State of Schleswig-Holstein in Clausthal-Zellerfeld for the approval of the general operating plan for the construction and operation of a drilling and production platform in blocks A6/B4 in the German North Sea of 22 March 1999 - 21 - 23/98 VI- W 60004 Bh. 29 - III -

The current sand, gravel and hydrocarbon extraction in the German North Sea is already technically secured by the competent authority. The impacts described above would therefore remain even if the plan were not implemented. However, by defining reserved areas, the use of raw material extraction will be more spatially concentrated and will be assigned greater importance in future spatial planning considerations. An impact on soil as an object of protection in the reserved areas is therefore more likely if the plan is implemented than if it is not implemented.

3.4.2 Benthos and biotope types

The following remarks are limited to the impacts of the uses on benthic communities. Since biotopes are the habitats of a regularly recurring community of species, impairments of the biotopes have direct effects on the biotic communities.

Sand and gravel extraction

A number of physical and chemical effects of sediment dredging (HERMANN and KRAUSE, 2000) are possible, which are also relevant for the marine benthos:

a) Substrate removal and alteration of soil topography. The most serious ecological impact of sand and gravel extraction is the reduction of the in or epifauna. The aspects of settlement density and biomass of benthic organisms are usually more affected than the number of species. In Dutch studies by MOORSEL AND WAARDENBURG (1990, 1991, currently ICES WGEXT 1998), settlement density was reduced by 70 % and biomass by 80 % immediately after extraction, while species numbers were reduced by only 30 %. Depending on the intensity and duration of the change in environmental conditions and sediment character, as well as the spatial distance for migrating species, the regeneration of the benthic fauna can take periods ranging from one month to 15 years or more (HERRMANN and KRAUSE, 2000). Recolonisation depends not only on physical factors such as water depth, current and sea state as well as sedimentological parameters, but also on species composition. It is particularly important that the sediment character has not been changed by dredging. In general, the recolonisation process can be divided into three phases (HERRMANN and KRAUSE, 2000):

- *Phase I*: Rapid recolonisation by species that were also dominant before degradation (predominantly opportunistic species); species and individual numbers increase rapidly and can sometimes reach the initial level after a short time; biomass, however, remains low.
- *Phase II*: Biomass remains significantly reduced over a longer period of time (several months to years). This may be caused by the loss of older year classes of long-lived species (e.g. bivalves such as *Mya arenaria, Cerastoderma* spp. and *Macoma balthica*) or the impediment of recolonisation due to the continued rearrangement of sediments disturbed by degradation.
- *Phase III*: The biomass increases markedly, the zoos regenerate completely.

  Very long-lasting changes in the benthic communities are observed in quarrying areas where a different sediment remains after dredging. The result is a permanent change in the bottom fauna, often towards soft bottom communities (HYGUM, 1993 cited in HERRMANN and KRAUSE, 2000). In certain cases, a permanent change from soft to hard soils with corresponding faunal change may also occur (HERRMANN and KRAUSE, 2000). According to ICES (2016), the recolonisation process is supported if the substrate after removal has comparable properties to the substrate before removal.

Based on the benthic ecological monitoring in 2010, 2013 and 2018 of the gravel sand storage area "OAM III" in the area of the nature reserve "Sylt Outer Reef - Eastern German Bight" (IFAÖ

2019a), it could be shown that if the previous extraction intensities were maintained within the extraction area, there would still be occurrences of the originally existing biotope types and in particular of species-rich gravel, coarse sand and shingle beds. At present, there are no indications that the previous extraction activities have led to a fundamental change in the sediment structure or composition in the extraction area. The abundance and species structure of the macrozoobenthos in the quarrying and reference areas show no statistically significant differences. Only the total biomasses are statistically significantly lower in the extraction area than in the reference area, as expected (IFAÖ 2019a). Overall, the studies show that the original substrate could be preserved in the area and that there is a regenerative capacity, especially for species-rich gravel, coarse sand and shingle beds. A change in the spatial extent of the species-rich gravel, coarse sand and shingle grounds is not to be expected as a result of the previous quarrying activities, since no losses of coarse sand areas and character species have occurred. The temporary losses of benthos in the extraction area will be compensated within a relatively short period of time due to recolonisation of the area with a comparable species community, so that no permanent impairments of the extraction areas are caused (IFAÖ 2019a).

In the ancillary provisions of the OAM III main operating plan of 03.12.2019, it was also stipulated that a "rock field/boulder field North Sea" demarcated by the Federal Agency for Nature Conservation in accordance with the reef mapping guide (BfN, 2018) will be excluded from quarrying and that "marine erratic blocks" within a radius of 75 m will not be impaired. In addition, it was specified that sufficient unmined areas remain between the extraction tracks so that the recolonisation potential with typical species-rich gravel, coarse sand and shingle beds continues to exist and the original substrate continues to be preserved. Corresponding requirements must also be included for future main operating plans in the SKN1 and SKN2 areas.

b) Change in hydrographic conditions. The change in bottom topography can cause changes in hydrographic conditions and thus also in water exchange and sediment transport. As a result of changes in bathymetry, there may be a local decrease in flow velocity, leading to deposition of fine sediments and local oxygen deficiencies (NORDEN ANDERSEN et al., 1992). This can be associated with consequences for the bottom fauna. According to GOSSELCK et al. (1996), although no effects on large-scale flow conditions are to be expected from sand and gravel extraction, small- and meso-scale changes must be considered.

c) Turbidity plumes*.* *Turbidity plumes* can essentially arise at three points in the degradation process (HERRMANN and KRAUSE, 2000):

- Due to the mechanical disturbance of the sediment in the seabed by the dredge head
- The overflow water flowing back from the dredger into the sea
- The dumping of unwanted sediment fractions (screening).

Although increased turbidity can be observed up to several hundred metres away from the dredge, and in individual cases can even be detected several kilometres away, the concentration of suspended material usually decreases very rapidly with distance (HERRMANN AND KRAUSE, 2000). A short-term occurrence of elevated concentrations of suspended matter does not appear to be harmful to adult mussels. The growth of filter-feeding mussels may even be promoted. However, eggs and larvae of a species generally react more sensitively than adults.

Although the concentration of suspended particles can reach levels that are harmful to certain organisms, the impact on marine organisms is considered to be relatively low, since such concentrations occur only spatially and temporally and are quickly degraded again by dilution and distribution effects (HERRMANN and KRAUSE, 2000).

d) Remobilisation of chemical substances. The resuspension of sediment particles can lead to the release of chemical compounds such as nutrients and heavy metals. The oxygen content can decrease when organic substances are brought into solution (HERRMANN and KRAUSE, 2000).

According to measurements during dredging in the Belt Sea, the concentration of inorganic nitrogen and phosphorus in the overflow water can be increased by a factor of 3 to 100 (HYGUM, 1993). With regard to nutrient levels, increases were measured up to a distance of 180 m behind the dredger, with the highest concentrations registered within the first 50 m (HERRMANN and KRAUSE, 2000). An increase in heavy metal concentrations (manganese and copper) was detected up to a distance of 12 m.

The chemical impacts are generally considered to be relatively low, as the commercially used sands and gravels usually have a low content of organic and clay components and thus hardly show any chemical interactions with the water column. Furthermore, the degradation activities are limited in time and space. In addition, waves and currents quickly dilute any increases in the concentration of nutrients and pollutants that may occur (ICES, 1992; ICES WGEXT, 1998).

e) Sedimentation and oversanding: The dispersal of sediment particles is highly dependent on the content of fine constituents and the hydrographic situation (especially sea state, current) (HERRMANN and KRAUSE, 2000). Drifting of suspended particles could be demonstrated in some cases up to 1,000 m from the dredging site. However, most of the material sediments at the extraction site or in its immediate vicinity. Furthermore, studies by KENNY and REES (1996) showed that sediments once disturbed by dredging can remain more easily mobile by tides and waves for a longer period of time. Such a degradation-induced increase in sediment mobility can also lead to over-sanding and impaired development of benthic organisms.

The practice of "screening" (dumping of unwanted sediment fractions) can also lead to a change in the bottom substrate towards mobile sand areas. The effects of sediment fallout from vessel spill on the benthic communities of areas not directly affected by dredging can vary widely. The following possibilities have been observed in previous studies (ICES 1992):

- Initially, as in the dredging area, an almost complete die-off of the benthic fauna, but the subsequent recolonisation is faster.
- The benthic fauna is damaged, but less severely than in the quarrying area, and subsequent recolonisation is faster.
- Species diversity and abundance are promoted in the sedimentation area.
- The impact is insignificant.

The main risk of sedimentation is the burial of sessile benthic organisms such as mussels and polychaetes. In addition, crustaceans such as lobsters may lose their habitat if the burrows and crevices they inhabit are buried. The edible crab, which is immobile during reproduction, is also at risk of burial and suffocation (ICES, 1992).

In summary, the main impacts of sand and gravel extraction on the marine benthos are as follows:

Direct effects:

- Temporary (short-term for opportunistic species; medium-term for long-lived species), regional (small-scale) loss of individuals of the benthic in and epifauna due to substrate removal.
- Temporary (short-term), regional (small-scale) damage to individuals, eggs and larvae of benthic organisms due to turbidity plumes.

- Temporary (short-term) and regional (small-scale) impairment of benthic organisms due to remobilisation of chemical substances.
- Temporary (short-term) and regional (small-scale) developmental impairments, possibly also loss of individuals of benthic organisms due to sedimentation and over-sanding.

Indirect effects:

- Temporary (short-term) and regional (small-scale) loss of settlement habitat for benthic organisms due to substrate removal, if sediment character is not altered by dredging.
- Permanent and regional (local) loss of settlement space due to possible changes in hydrographic conditions.
- Temporary (short-term) and regional (small-scale) influence on the food supply for benthic organisms through impairment of primary production (phyto- and zooplankton) due to remobilisation of chemical substances.

Extraction of hydrocarbons

The conceivable impacts on benthic communities caused by offshore platforms for the extraction of natural gas can be divided into three areas. These include construction- and installation-related effects as well as operational effects.

The construction and installation-related impacts can largely be taken from Chapter 3.2.2on offshore wind energy.

In summary, the main impacts of natural gas extraction on marine benthos are as follows:

Direct effects:

- Small-scale and short-term habitat loss for the duration of foundation installation due to sediment swirl and turbidity plumes.
- Short-term and small-scale damage to individuals, eggs and larvae of benthic organisms due to turbidity plumes.
- Short-term and small-scale impairment of benthic organisms due to possible remobilisation of chemical substances.
- Small-scale and permanent loss of settlement space due to the piers of the platform because of the land use.
- Small-scale and permanent supply of artificial hard substrate due to the layout of the platform.
- Small-scale and permanent change in sediment parameters due to the installation of the platform.

Indirect effects:

Short-term and small-scale influence on the food supply for benthic organisms through impairment of primary production (phyto- and zooplankton) due to possible remobilisation of chemical substances.

3.4.3 Fish

Sand and gravel extraction

The extraction of sand and gravel in the North Sea can alter habitats and mean a loss of habitat for fish fauna. In addition, substrate extraction results in turbidity plumes with associated sedimentation and resuspension of sediment particles, which can affect fish fauna.

During the removal of substrates, fish are usually scared away from their habitat. Loss **of area depends on the** geological composition of the removed material. A change in sediment type after removal may make recolonisation difficult for some species. Fish are significantly affected by the impacts of sand and gravel extraction, especially when the extraction areas overlap with spawning grounds, which is only the case for a few species in the North Sea EEZ, such as the sand eel (HERRMANN & Krause 2000). Sand eels use sandbanks as staging, overwintering and spawning grounds (IFAÖ 2019a). Sand eels burrow into sediments and lay their eggs there. Due to this way of life, no representative findings on densities and population sizes in the sand and gravel extraction area could be made during surveys in 2002 and 2010 (IfAÖ 2019a). Therefore, a materiality assessment of the impacts of resource extraction cannot be made.

It should be noted that a loss of habitat for sand eels, which are a main food source for harbour porpoises, grey seals and various seabird species, could also affect other protected goods via the food web. Links between sandeel abundance and bird breeding success have been demonstrated for kittiwakes, for example (MacDonald et al. 2019). Fish themselves are also indirectly affected by the loss of food resources, as sand and gravel extraction is associated with a reduction in invertebrate invertebrate and epifauna in the area.

Sand and gravel mining also creates **sediment swirls and turbidity plumes, which** - albeit temporary and species-specific - can cause physiological impairments and entanglement. Predators that hunt in open water, such as mackerel and wood mackerel, avoid areas with high sediment loads and thus avoid the danger of adhesion of the gill apparatus (Ehrich & Stransky 1999).

A threat to these species as a result of sediment turbulence does not appear likely due to their high mobility. A negative impact on bottom-dwelling fish is also not to be expected due to their good swimming characteristics and the associated possibilities for evasion. In plaice and sole, increased foraging activity has even been observed after storm-induced sediment turbulence (Ehrich et al. 1998).

In principle, however, fish can avoid disturbances due to their well-developed sensory abilities (lateral line organ) and their high mobility, so that impairments are unlikely for adult fish. Eggs and larvae, in which the reception, processing and implementation of sensory stimuli are not yet or not very well developed, are generally more sensitive than adult conspecifics. After fertilisation, fish eggs develop a dermis that makes them robust to mechanical stimuli, e.g. to swirling sediments. Although the concentration of suspended particles can reach levels that are harmful to certain organisms, the effects on fish are considered to be relatively low, as such concentrations occur only spatially and temporally and are quickly degraded 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). Resuspension of sediment particles can lead to the release of chemical compounds such as nutrients and heavy metals. Oxygen levels may decrease when organic matter is brought into solution (Herrmann & Krause 2000). The chemical impact is generally considered to be relatively low for the North Sea, as the commercially used sands and gravels usually have a low content of organic and clay components and thus show little chemical interaction with the water column.

With **sedimentation of** the released substrate, the main risk is coverage of fish spawn deposited on the bottom. This can result in an undersupply of oxygen to the eggs and, depending on the degree of effectiveness and duration, can lead to damage or even death of the spawn. For most fish species occurring in the EEZ, spawning damage is not to be expected, as they either have pelagic eggs and/or spawn in shallow water outside the EEZ. The early life stages may also be adapted to turbulence, which regularly recurs in the North Sea as a result of natural phenomena such as storms or currents.

The above-mentioned impacts of sand and gravel extraction on fish fauna occur independently of the non-implementation or implementation of the plan.

Extraction of hydrocarbons

Production platforms are erected for the extraction of hydrocarbons, which can affect the fish community during the construction and operation phases.

During seismic surveys and exploration drilling of the natural gas fields, as well as during platform construction, there are increased sound emissions. The effects of sound on fish are described in detail in Chapter 3.2.3 Construction-related sediment turbulence, turbidity plumes and resuspension of sediment particles can affect fish locally and in the short term, as already described for sand and gravel extraction. Due to the construction-related impairments, short-term and small-scale scaring effects for fish may therefore occur.

The impacts caused by the foundation of the platform are comparable to those of offshore wind turbines. There is a permanent loss of habitat for demersal fish species and their food base, the macrozoobenthos, in the area of the foundations.

Furthermore, the newly introduced substrate changes the structure of the seabed in the North Sea. Some fish species, such as cod or French cod, aggregate on artificial structures (e.g. GLAROU et al. 2020). Detailed information on the effects of newly introduced structures is described in chapter 3.2.3

Effects due to the escape of pollutants in the event of an accident cannot be ruled out and can be considerable.

The above-mentioned impacts of natural gas extraction on fish fauna occur independently of the non-implementation or implementation of the plan.

3.4.4 Marine mammals

Sand and gravel mining

Sand and gravel extraction may cause sediment plumes and sediment alteration, with associated damage or alteration to benthic communities. Temporary impacts on marine mammals due to noise emissions from the vehicles involved in the extraction would also be expected. In particular, turbidity plumes and changes in sediment structure and benthos may impact on the quality of habitat for marine mammals. However, these are local and temporary and thus any disturbance would be insignificant.

Non-implementation of the plan would not affect the existing or described impacts of sand and gravel extraction on harbour porpoise, harbour seal and grey seal.

Extraction of hydrocarbons

Possible impacts on marine mammals from the construction and operation of offshore platforms for the extraction of natural gas may be caused by vessel traffic, noise emissions, pollution from pollutant spills and sediment plumes. During normal operation, sediment and benthic changes are to be expected from platforms. Attraction effects on fish caused by changes in the composition of the benthos can in turn lead to attraction effects for marine mammals (consumers). Collisions of harbour porpoises with platforms are not known. In the event of accidents, pollutants may be released into the marine environment, which may lead to contamination of marine mammals.

Direct disturbance of marine mammals at the individual level can only occur during the construction phase of gas production platforms. However, impacts from shipping traffic and especially from noise emissions during the construction phase are only to be expected regionally and for a limited period of time. The formation of sediment plumes is largely to be expected only locally and also for a limited period of time. A loss of habitat for marine mammals could thus occur locally and for a limited period of time.

Indirect effects due to pollutant discharges during normal operation and accumulation in the food chains should be prevented by appropriate state of the art measures. Impacts due to pollutant leakage in the event of a malfunction or accident cannot be ruled out. These would predominantly occur selectively.

Non-implementation of the plan would not affect the existing or described impacts of carbon extraction on harbour porpoise, harbour seal and grey seal.

3.4.5 Seabirds and resting birds

Sand and gravel mining

For seabirds, the extraction of sand and gravel can have impacts primarily through turbidity plumes and visual disturbance from shipping traffic. Indirectly, sediment changes and associated changes in benthic communities can affect seabirds and resting birds through the food chain. These impacts are generally weak for seabirds and resting birds, as the birds forage for their prey organisms predominantly in the water column in widespread areas.

The direct impact of turbidity plumes on seabirds varies according to species and feeding strategy. Moreover, the turbidity plumes only lead to local water turbidity.

Shipping traffic during mining operations can lead to avoidance behaviour and thus a temporary loss of habitat for species sensitive to disturbance.

Overall, impacts on seabirds and shorebirds due to shipping traffic and the formation of turbidity plumes as a result of dredging are regional and limited to the duration of the extraction work.

The above-mentioned impacts on seabirds and resting birds occur independently of the non-implementation or implementation of the plan.

Extraction of hydrocarbons

For seabirds and resting birds, the construction and operation of hydrocarbon extraction facilities may potentially result in impacts from use-related shipping traffic in the form of visual disturbance and sediment plumes. In addition, sediment and benthic changes may occur. Attraction effects on fish due to altered composition of the benthos can in turn lead to attraction effects for their consumers, in this case seabirds (LOKKEBORG et al. 2002, FABI et al. 2004). In the event of accidents, pollutants and oil can be released into the marine environment, which can also result in contamination of seabirds. Depending on the technical implementation of hydrocarbon extraction, plant-related impacts on seabirds and resting birds may be comparable to those of offshore wind energy (see Chapter 3.2.5).

Impacts from use-related shipping traffic are to be expected above all for species sensitive to disturbance, such as divers, but have only a regional and temporary effect.

The formation of sediment plumes is largely to be expected only locally and also for a limited period of time.

Impacts due to sediment and benthic changes are generally weak for seabirds, as they predominantly search for their prey organisms in the water column in widespread areas.

According to current knowledge, the impacts on seabirds and resting birds caused by the extraction of hydrocarbons are mainly temporary and spatially limited. For further potential impacts comparable to the impacts of offshore wind energy, please refer to Chapter 3.2.5

The above-mentioned impacts on seabirds and resting birds occur independently of the non-implementation or implementation of the plan.

3.4.6 Migratory birds

Sand and gravel mining

Effects of sand and gravel extraction on migratory birds can mainly be due to attraction effects of the illuminated extraction vehicles. These can be particularly effective at night in poor visibility and weather conditions, which can lead to collisions.

The above-mentioned impacts on migratory birds occur independently of the non-implementation or implementation of the plan.

Extraction of hydrocarbons

The extraction of hydrocarbons can lead to attraction effects from illuminated structures. Depending on the technical implementation of hydrocarbon extraction, there may be plant-related effects comparable to those of offshore wind energy (see Chapter 3.2.6).

The above-mentioned impacts on migratory birds occur independently of the non-implementation or implementation of the plan.

3.4.7 Bats

Sand and gravel extraction

Effects of sand and gravel extraction on bats may exist to a minor extent due to attraction effects of the illuminated extraction vehicles.

The above-mentioned impacts on bats occur regardless of whether the plan is not implemented or is implemented.

Extraction of hydrocarbons

The extraction of hydrocarbons can lead to attraction effects from illuminated structures. Depending on the technical implementation of hydrocarbon extraction, there may be plant-related effects comparable to those of offshore wind energy (see Chapter 3.2.7).

The above-mentioned impacts on bats occur regardless of whether the plan is not implemented or is implemented.

3.4.8 Air

Sand and gravel extraction

Shipping traffic associated with sand and gravel extraction will result in pollutant emissions that may affect air quality. Significant adverse impacts on air quality are not expected.

Extraction of hydrocarbons

There are emissions associated with the extraction of hydrocarbons that can affect air quality. In particular, emissions come from shipping traffic associated with offshore activities (e.g. utilities), drilling activities, construction activities (e.g. driving foundation piles) and from the operation of production platforms. Platform operations emit e.g. carbon dioxide, nitrogen oxides and volatile organic compounds including methane. Significant adverse impacts on air quality are not expected.

3.4.9 Cultural assets and other material assets

In principle, large-scale intervention in the seabed, for example dredging for sand and gravel extraction, increases the probability of encountering archaeological traces. The primary risk here is completely covered, previously unknown wrecks and prehistoric sites. In addition, dredging can influence currents and thus lead to local erosion, which successively covers and eventually destroys new archaeological sites (cf. Gosselck et al. 1996).

The same applies to the removal of stone material, which was practised as nearshore stone fishing as early as 1840-1930 and to depths of 6-12 m in 1930-1976 (Bock et al. 2003). Besides the change in flow and erosion conditions, wrecks can also be directly affected when the ballast stones above a wreck site are removed.

3.5 Fisheries and aquaculture

Traditionally, the entire EEZ in the North Sea and Baltic Sea is used for fishing. In the North Sea EEZ, a distinction must be made between coastal and cutter fishing and small-scale deep-sea fishing. These differ mainly in the size of the vessels and the motorisation. Large-scale industrial deep-sea fishing, which lands roughly half of the German catches with a few vehicles, does not take place in the German EEZ.

In the North Sea, cutter fishing, mostly with vessels of 18 - 24 m in length, accounts for the largest share of fishing effort. Small-scale deep-sea fishing, which only accounts for a small share of the German fishing fleet, is carried out with often more heavily motorised deep-sea cutters of up to 32 m in length.

Fishing is mainly demersal (on the seabed) with beam trawls or bottom trawls, or pelagic with trawls.

The largest share of fishing operations and also the largest catches in the North Sea are accounted for by shrimp fishing (North Sea crab, *crangon crangon*), plus mainly flatfish such as plaice or sole. The smaller cutters are allowed to fish in the so-called "plaice box" in the east of the EEZ and the territorial sea, but more powerful vessels may only fish for flatfish outside it. Other target species of pelagic fisheries are herring, mackerel, saithe or cod.

Companies from neighbouring countries, especially from the Netherlands, Denmark and the United Kingdom, account for a large share of the catches, especially of crabs, but also with larger catches of sprat or sand eels. The latter, however, are of no significance for German fisheries.

Spatially, several focal areas can be identified based on VMS data, here from 2014 (Thünen, 2017): the crab fishery on the eastern edge of the EEZ, plus the northern edge of the Sylt Outer Reef Conservation Area, as well as in the western half up to the Duck's Bill with a focus on the Southern Mudflats, which is a main fishing area for Norway lobster.

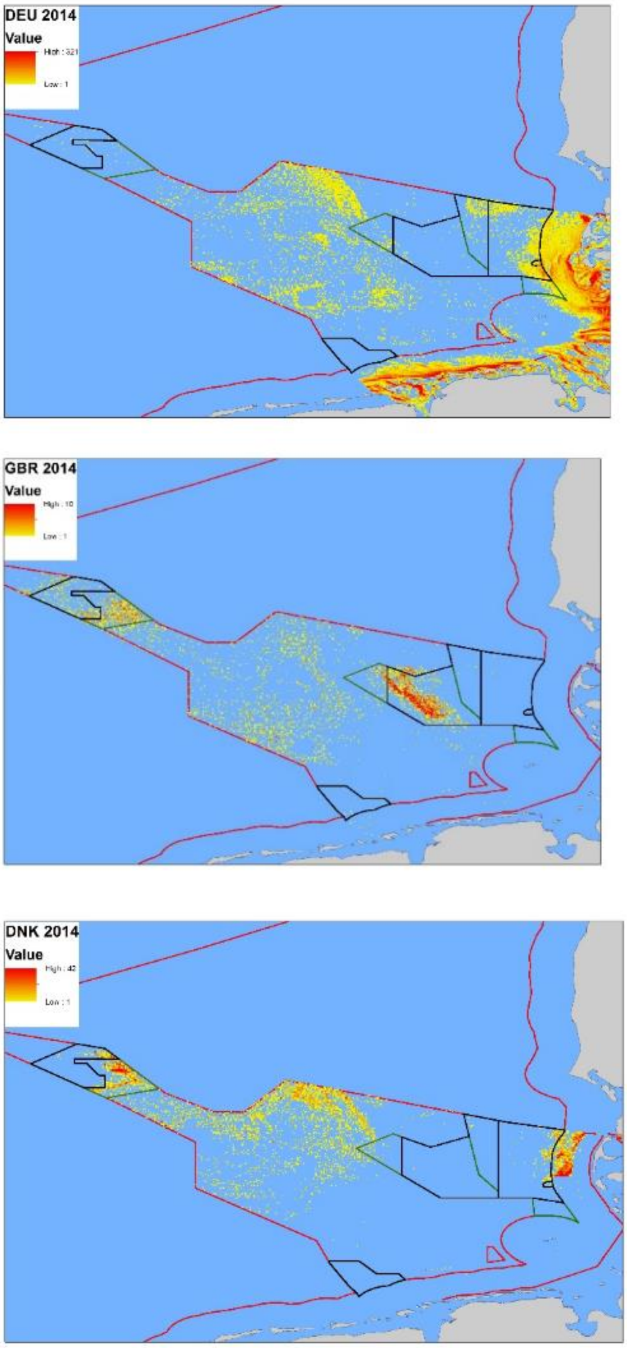
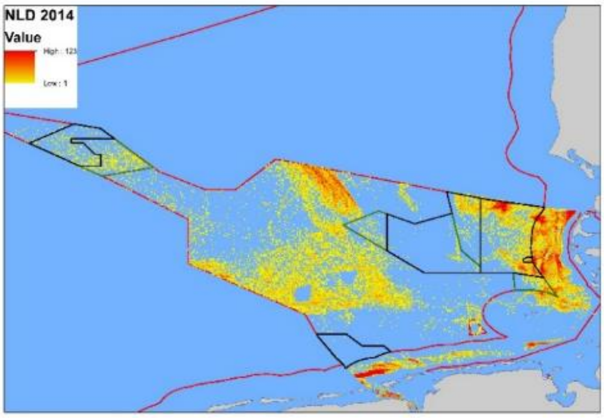


Figure 44: Fishing effort in the territorial sea and EEZ based on VMS data 2014 for individual national fleets (DEU: Germany; NLD: Netherlands; DNK: Denmark; GBR: UK). (Thünen, 2016)



Development of fisheries

Overall, fisheries in the North Sea are in decline, with sharp declines in yields recorded especially in the near-bottom and near-touch fisheries. The number of vessels in the German fishing fleet as a whole has fallen from 2315 (2000) to 1329, with the decline mainly due to the reduction in the number of vessels in the Baltic Sea.

Only a few (currently 7) ocean-going trawlers operating worldwide land about half of the German catch. The majority of the remaining vessels, about 1,110, are small gillnet cutters (4 - 10 m in length) operating in the Baltic Sea near the coast. These account for only about 4% of the catches. Around 200 crab trawlers (9 - 27 m long) operate in the North Sea. Bottom trawling, especially for cod and saithe, is carried out by about 70 cutters in the North Sea and Baltic Sea (Thünen Institute of Sea Fisheries 2018).

Restrictions on fishing take place at the level of the EU's Common Fisheries Policy in terms of catches, fishing gear and fishing areas. The annual quota setting in particular has a major influence on the economic framework conditions of the fishing companies. For example, the currently very strongly reduced fishing quotas for herring and cod in the Baltic Sea for 2020, based on scientific recommendations, are seen by many businesses as a threat to their existence. It is expected that the economic situation of the fishing companies will become even worse in the coming years.

Spatial restrictions with regard to target species, use of fishing gear or time limits, each with shares in the German EEZ, have been enacted under EU law in the North Sea ("Plaice Box") and in the Baltic Sea ("Oder Bank"). Fisheries management measures in the nature reserves based on Joint Recommendations of the states of the Scheveningen Group (North Sea) and the BaltFish Group (Baltic Sea) will be introduced within the framework of the respective management plans for the NSGs. For the North Sea, the draft Joint Recommendation is awaiting a decision by the EU; for the Baltic Sea, only a few proposals have been drafted.

In addition to the influence of the EU's Common Fisheries Policy on the fisheries sector in the EEZ, the construction of offshore wind farms in particular has a spatial impact on fisheries. The establishment of safety zones for fixed infrastructure (wind turbines, transformer and converter platforms) has led to a far-reaching ban on navigation in and around the wind farms. The use of fishing gear such as bottom, trawl and drift nets is also generally prohibited in the safety zones. In 2019, large areas in the EEZs of the North Sea and Baltic Sea will no longer be usable for fishing. In addition, from the point of view of fisheries, there are further restrictions in the course of cable connections outside the wind farms, which may not be fished over everywhere for safety reasons.

Aquaculture

Currently, no specific aquaculture projects are planned in the German EEZ of the North Sea and the Baltic Sea. However, in order to keep options open for such marine use in the future, the maritime spatial plan contains a general specification of possible installations in spatial proximity to offshore wind energy plants, but without a specific spatial specification.

From various research projects, among others involving the AWI and the TI for Sea Fisheries, the following areas in the North Sea EEZ have been identified as generally suitable for the cultivation of extractive species (mussels, algae), with aquaculture seen as possible in stand-alone use or co-use of safety zones of existing wind farms, as well as in use of entire future wind farms : a) southern German Bight (in the area between the traffic separation areas "Western Approach" and "Terschelling German Bight", from the Dutch border to the deep water speech to the Jade, Weser or Elbe), b) in the Helgoland cluster (Reserved Area Offshore Wind Energy EN4), as well as c) around the current research platform FINO 3 (in the area of OWP Sandbank and Dan Tysk).

The cultivation of extractive species such as mussels or algae can be assumed to be relatively extensive. The joint use of infrastructure for the operation of the respective wind farm is considered desirable (ships, transfer of people, etc.).

The following potential impacts may occur from fishing exploitation of the EEZ, as well as from aquaculture of extractive species:

Table 22: Effects and potential effects of fisheries and aquaculture (t= temporary).

Use	Effect	Potential impact	Protected goods																
			Benthos	Fish	Seabirds and	Migratory birds	Marine mammals	Bats	Plankton	Biotope types	Biodiversity	Floor	Area	Water	Air	Climate	Man/ Health	Cultural and mate-	Landscape
Fishing	Removal of selected species	Reduction of stocks	x	x							x								
		Degradation of the food base			x														
	Bycatch	Reduction of stocks	x	x	x		x				x								
	Physical disturbance by trawls	Impairment/ Damage	x	x			x			x		x						x	
Aquaculture	Introduction of nutrients	Impairment	x	x					x					x					
	Bringing in fixed installations	Habitat modification	x	x					x	x	x								x
		Habitat and land loss	x	x	x					x			x					x	x
	Introduction and spread of invasive species	Change in species composition	x	x	x				x		x								
	Insertion of medicines	Impairment	x	x										x			x		
	Removal from wild stocks	Impairment	x	x															
	Attraction/shying effects	Attraction / scare effect		x	x		x												

3.5.1 Floor

Fishing

Fishing gear used in *bottom-dwelling fisheries* (e.g. otter trawls, dredges, beam trawls) has an impact on the bottom as a protected resource. In the German EEZ of the North Sea, beam trawl fishing is the main activity, with the greatest intensity in the southern North Sea. Often several times a year, the seabed is churned up to an average depth of 10 cm, depending on the bottom conditions (ICES, 2000). This temporally and spatially variable intervention is subject to relatively rapid regeneration in the course of natural sediment dynamics, so that the drag marks usually disappear within a few days to weeks. Nevertheless, the use of bottom trawls results in a certain smoothing of the seabed by levelling ripple structures or smaller bottom elevations. The fishing away of stones can lead to a change in the sediment structure and habitat levelling.

The near-bottom formation of turbidity plumes and possible release of contaminants from the sediment is generally negligible due to the generally low proportion of silt and clay, the low concentrations of heavy metals and the prevailing current conditions. In intensively fished areas such as the Outer Silver Pit, grain refinement on the seabed surface has been observed, which, in addition to natural causes, can also be attributed to sediment resuspension by bottom trawls and subsequent resedimentation (TRIMMER et al., 2005).

The impacts on soil as a protected resource are independent of the non-implementation or implementation of the plan.

Aquaculture

Currently, there are no concrete plans regarding co-use of aquaculture in the EEZ of the North Sea and Baltic Sea.

Depending on the type of aquaculture, nutrients and solids may enter the seabed directly or indirectly via the water column through feed or the excreta of the cultures used. Further adverse effects are to be expected from the preventive or treatment use of medicines and other chemical substances for various purposes. All of the substances introduced can lead directly or indirectly via the water column to pollutant loads or to an increased input of organic substances into the seabed. The extent of the impact on the seabed will depend on the type and intensity of aquaculture.

The preconditions for marine aquaculture are to be examined at downstream planning levels. The described impacts of aquaculture on soil as a protected resource therefore arise independently of the non-implementation or implementation of the plan.

3.5.2 Benthos and biotope types

Fishing

Fishing for demersal fish species is important for the benthos and biotopes. To catch bottom-dwelling fish, gear is used, parts of which penetrate the bottom and alter the animal community living there. The fishing gears are the otter trawl, which is used to catch cod and haddock, the beam trawl to catch flatfish (sole, plaice) and the dredge, which is used to catch mussels (WEBER et al., 1990). In the German EEZ of the North Sea, beam trawl fishing for flatfish and shrimp is mainly practised. The bottom is churned up to a depth of 10 cm by the skids of the beam trawls and by the harness (chafing chains or chain mats) (LINDEBOOM et al., 1998). The otter boards of the otter trawl have the same effect. They usually slide across the bottom at an angle, leaving furrows that can be up to 10 cm deep, depending on the bottom conditions (ICES, 2000). The intensity of bottom fishing varies greatly, with the southern North Sea being the most intensively visited within the German EEZ. Depending on the behaviour of the fishermen, it is not uncommon in this area for the seabed to be fished up to ten times or more a year with beam trawls or similar gear (EHRICH, 1998).

Fishing activities can kill off organisms of the epi- and endobenthos due to the mechanical stress or they are removed from the system and usually returned overboard damaged. The degree of damage depends not only on the type of sediment and the penetration depth of the fishing gear, but also on the species composition of the benthos and, of course, on the frequency with which an area is fished. During the fishing process, the majority of the organisms of the epi- and endobenthos (about 90 per cent) pass through the net meshes and thus do not reach the deck of the vessels. An unknown proportion is killed directly by the fishing gear. The survival rate of invertebrates returned overboard depends on the species and varies from < 10 % (starfish) to 90 % (Iceland clam). In general, animals living buried in mud-rich bottoms are more sensitive to beam trawl scouring chains than animals living in sand (SCHOMERUS et al., 2006). Otter trawls generally have less impact on animals burrowing in the soil, as otter trawls affect a smaller area than beam trawls. The sessile epibenthos is comparably affected by otter trawls as by beam trawls if the otter trawls are equipped with chains instead of a light roller gear as ground gear.

The effects of fishing gear on benthic communities can be separated into short-term and long-term effects (Weber et al., 1990):

- Short-term consequences. Some of the animals exposed by the fishing gear are injured or killed. The larger and hard-shelled representatives, such as sea urchins and swimming crabs, are particularly susceptible to this. Smaller benthic animals such as brittle stars and thin-shelled small bivalves are hardly damaged (Graham, 1955). The exposed and damaged animals are welcome food for fish from the surrounding area. Margetts and Bridger (1971) made the observation that dab seemed to be more numerous and more voracious in the towed lane than in the surrounding area.
- Long-term consequences. Fishing activities increase the mortality of sensitive species until only the opportunists can exist. Diversity, a measure of species abundance, decreases at the same time. Abundance increases for the species that are not harmed by the fishing gear as the sensitive species disappear from the biotope. Organic matter production may increase first as the older, slow-growing specimens are replaced by fast-growing, young specimens. As trawla activity increases, the younger animals will then also die, so that production decreases.

In summary, the main impacts of fishing on marine macrozoobenthos are as follows:

- Loss of individuals, especially of long-lived and sensitive species, due to fishing gear
- Reduction of sessile epifauna
- Decrease in biodiversity
- Shift in the size spectrum of the soil fauna
- Habitat levelling by fishing away stones.

The above-mentioned impacts on benthic communities and biotope types occur independently of the non-implementation or implementation of the plan.

Aquaculture

Aquaculture involves the production of fish, crustaceans (shrimp), molluscs (mussels) and algae under controlled conditions in dedicated facilities in saline or brackish water. Mariculture is a growing market worldwide. There is currently no mariculture in the German EEZ of the North Sea. Only in the coastal waters of the North Sea are mussels kept in largely protected locations.

Larger amounts of nutrients can be released from aquaculture facilities, e.g. net cage facilities for rearing fish, depending on the species reared, as not all nutrients fed in fish cultures are converted into biomass. In addition to the soluble excretory products of farming, solids can be distributed in the water column and lead to a constant increase in nutrient concentrations in the vicinity of cage facilities and benthic habitats. Since microalgae cannot convert the nutrient supply in time, excreted solids and uneaten food pellets could therefore accumulate under the cages (depending on the flow), possibly causing local eutrophication effects (WALTER et al., 2003). Due to the microbial degradation of the substances, there is a risk of oxygen deficiency situations and thus an impairment of the benthic habitats.

Intensive farming of fish in aquaculture requires the use of medicines to prevent and treat diseases to which mass cultures are particularly susceptible. Apart from veterinary substances, disinfectants and antifouling agents are also used in aquaculture (WALTER et al., 2003). The substances introduced into the system can lead to pollutant loads in the water column and sediments.

Bivalve cultures can also have impacts on the taxonomic and functional diversity of benthic communities and biogeochemical processes through biodeposition of faeces or pseudofaeces (LACOSTE et al. 2020). These impacts vary depending on the species harboured and are also variable over time. Possible ecosystem impacts, for example through attraction, avoidance effects and food web interactions, cannot be ruled out, but have so far been insufficiently studied (LACOSTE et al. 2020).

Often the species cultivated in aquaculture are not native species. If such cultured organisms escape, there is a risk that they will spread. An example of this is the Pacific oyster, which was introduced into German waters through aquaculture.

However, the escape of native species from farms may also endanger the environment. In addition, parasites from aquaculture facilities can also enter the marine environment (WALTER et al., 2003).

The above-mentioned impacts of aquaculture on benthos and biotopes occur independently of the non-implementation or implementation of the plan.

3.5.3 Fish

Fishing

The fishery in the entire North Sea comprises about 6600 vessels and is concentrated over 100 fish stocks (ICES 2018a). Some areas of the southern North Sea are fished up to ten times per year with bottom-towed gear (ZIDOWITZ et al. 2017). In the southern North Sea, the main traditional fishery is for North Sea shrimp in the territorial sea. Flatfish fisheries in the German EEZ target saithe, cod, plaice and sole (ICES 2018a). Fishing often involves not only hauling heavy bottom gears, but also using relatively small meshes, as a result of which bycatch rates of small fish and other marine animals can be very high.

The environmental impacts resulting from fishing are manifold and in some cases considerable. The fundamental problem is the excessive fishing effort and the overfishing of some stocks (see also Chapter 2.7.3Prior exposure). Negative to critical stock development is a major problem in the North Sea, as is the bycatch of juvenile yearlings, because this deprives the stocks of their future reproductive potential. As a result, commercial fish stocks in the North Sea often do not have their full reproductive potential. In addition to the direct mortality of target species, non-targeted bycatch species are potentially at risk from fishing. In particular, sharks and rays are very sensitive to fishing pressure due to very slow growth, late sexual maturity and low fecundity, with the possible consequence of population declines in the North Sea (ZIDOWITZ et al. 2017). In addition, demersal fishing has a negative impact on invertebrates, which serve as an important food source for many bony and cartilaginous fish.

Another impact of intensive fishing is the change in the age and length structure of fish due to size-selective fishing methods. Primarily larger older individuals are taken, so that the proportion of smaller younger individuals in the fish community increasingly predominates. This change in the fish community probably has consequences above all for the reproduction of fish stocks. In general, small fish produce fewer and smaller eggs than their larger counterparts. Their fry are also more sensitive to a variable environment and may be subject to increased mortality (TRIPPEL et al. 1997). This impact of fishing can lead to population declines and changes within the community (such as dominance relationships).

In addition to the direct impacts of fishing, the input of marine litter, especially plastic waste, can lead to indirect negative impacts on fish fauna. Especially abandoned fishing nets that drift around for decades and continue to be fished pose a problem for fish fauna. Mortality from fishing ghost nets could contribute to stock decline and be a problem especially for endangered fish species.

The above-mentioned impacts of fishing on fish fauna occur regardless of whether the plan is not implemented or is implemented.

Aquaculture

The implementation of co-use, e.g. which species are kept in which stocking densities, has not been specified at the present time and must be regulated at subsequent planning levels, taking into account the special features of the project area. Suitable aquaculture sites could primarily be the OWPs closer to the coast, as costs and effort increase with increasing distance from the coast.

In general, aquaculture can reduce fishing pressure on some wild fish stocks. Avoiding the use of juvenile fish from wild stocks is crucial here. Adverse effects of marine aquaculture on fish fauna can come in particular from the introduction of diseases and invasive species, as well as from the increase in nutrients and pollutants.

In the case of disease outbreaks, parasites and pathogens can lead to an increased risk of transmission to natural stocks in the surrounding water close to the plant. The escape of cultured organisms is also problematic; if they mix with natural conspecifics and participate in reproduction, genetic diversity can be endangered (WALTER ET AL. 2003). If alien fish species escape and are able to establish themselves, native fish species can be displaced. Stocking of net cages for fish rearing should therefore only be done with native species.

A further impairment can come from the input of nutrients and pollutants. Intensive feeding, especially when fish are reared in net cages, increases the nutrient concentration and can pollute the seabed with organic load. These environmental impacts could be reduced with an adapted stocking density and a more extensive distribution of net cages in the area (HUBOLD & KLEPPER 2013). Exposure to medicines or other environmental chemicals (e.g. anti-fouling) could also be reduced in this way. In general, a tolerable level of nutrients and pollutants should enter the marine environment through aquaculture in order to exclude significant impacts on wild stocks of fish fauna.

The above-mentioned preconditions for marine aquaculture are to be examined at downstream planning levels. The above-mentioned impacts of aquaculture on fish fauna therefore arise independently of the non-implementation or implementation of the plan.

3.5.4 Marine mammals

Fishing

In the North Sea, beam trawls and trawl nets are the main gear used by fisheries. The main threat to harbour porpoises in the North Sea is unwanted bycatch in nets (ASCOBANS, 2003, Evans 2020).

Non-implementation of the plan would not affect the existing or described impacts of fishing on harbour porpoise, harbour seal and grey seal.

Aquaculture

Marine mammals would be affected indirectly via water quality degradation and food chains in the case of mariculture establishment: contaminants, especially growth hormone preparations and antibiotics, could affect the immune system of marine mammals. Changes in the lowest part of the food chains could affect the entire food chains and thus upper predators, such as marine mammals.

It cannot be ruled out that seal deterrence measures, which are often used in fish aquaculture operations, would also have a disturbance effect on the harbour porpoise population.

According to current knowledge and due to a lack of concrete planning, it is not possible to assess impacts from aquaculture in the EEZ.

Non-implementation of the plan would not affect the existing or described impacts of mariculture on harbour porpoise, harbour seal and grey seal.

3.5.5 Seabirds and resting birds

Fishing

Fisheries influence the occurrence of seabirds. Discards of bycatch from fishing activities provide additional food sources for some seabird species. This creates concentrations around fishing vessels. In particular, fulmar, skua, herring gull, herring gull and great black-backed gull benefit from discards. In one study, a trend towards increased numbers of birds (Herring Gull, Herring Gull, Skua and Black-headed Gull) with a corresponding increase in the number of fishing vessels could be clearly identified (GARTHE et al. 2006). In addition, fishing can have disturbance and scaring effects on seabirds and resting birds, which depend on the frequency of use of the marine areas. In addition, there is a risk of birds dying as bycatch in fishing nets.

The overfishing of important stocks that provide food for various species of seabirds also leads to food limitation. Indirect effects of food limitation or switching to other fish species as a food source are reduced reproductive success and impaired survival of many bird species. In particular, effects of overfishing and the decline of sand eel stocks are known from the North Sea (FREDERIKSEN et al. 2006). For example, observations of reduced reproductive success in kittiwakes and guillemots from British breeding colonies are linked to the decline of sand eel as the main food for chicks. The proliferation of the sand eel-like snake darter in the North Sea, which is often used by parent birds to feed chicks instead of sand eel, is not scientifically proven to be an equivalent food. Because of the hard consistency of the snake needles, the young birds are not able to use them as food. As a result, they remain undernourished or starve to death (WANLESS et al. 2006).

Effects of fishing can thus be limited in time and space by the actual fishing process, but can also be large-scale and long-lasting through changes in food availability and prey range.

Aquaculture

The management of aquaculture facilities is associated with vessel transport and various offshore activities at the facilities, which cause small-scale visual and acoustic disturbance and scaring.

The above-mentioned impacts of fisheries and aquaculture on seabirds and resting birds occur independently of the non-implementation or implementation of the plan.

3.5.6 Migratory birds

Fishing

Migratory birds may be disturbed and frightened by fishing, depending on the frequency of use of the marine areas. For migratory waterfowl that interrupt their migration to feed, there is also the risk of becoming entangled in fishing nets and drowning.

Aquaculture

The management of aquaculture facilities is associated with vessel transport and various offshore activities at the facilities, which cause small-scale visual and acoustic disturbance and scaring.

The above-mentioned impacts of fisheries and aquaculture on migratory birds occur irrespective of the non-implementation or implementation of the plan.

3.5.7 Cultural assets and other material assets

Trawl fishing can contribute to the destruction of archaeological layers and wreck finds. The trawls and their otter boards penetrate the sediment of the seabed and can leave furrows up to 50 cm deep and 100 cm wide on fine sandy bottoms, which are even visible in the side-scan sonar image (Firth et al. 2013, 17). In individual cases, the proximity to wrecks is deliberately sought, which form natural habitats as a hard substrate and in whose vicinity larger fish populations can be expected. Worldwide, there are already many documented examples of destruction of underwater cultural heritage caused by trawling (Atkinson 2012, 101). On the other hand, information on net hangers, when reported by fishermen, can also contribute to the discovery of underwater cultural heritage.

3.6 Marine research

Extensive research and environmental monitoring activities take place in the German EEZ of the North Sea and Baltic Sea. According to Art. 56 para. 1 UNCLOS, the coastal state has sovereign rights to explore and exploit, conserve and manage the living and non-living natural resources of the waters above the seabed.

The BSH itself has been operating the MARNET monitoring network since 1989 - with the majority of the measuring stations in the German EEZ and a few more in the coastal seas in the North Sea and Baltic Sea. The systematically designed measurements are used for long-term marine environmental monitoring. Unmarked ground racks with measuring instruments are installed around the stations at a distance of about 500 - 1000 m. The measuring stations are located in the coastal sea.

In the North Sea, this also includes the first FINO measuring mast (Research Platform in the North and Baltic Seas - FINO 1) erected in 2004 near the future alpha ventus offshore wind farm, as well as FINO 3 near Dan Tysk. The measuring masts are used to measure the environmental conditions before the wind farms are built - and to monitor the changes, disturbances, impacts and interactions after the offshore wind farms have been built. All measuring masts are now located in or near the wind farms mentioned.

The Alfred Wegener Institute for Polar and Marine Research (AWI), the Thünen Institutes, the Institute for Baltic Sea Research (IOW) and other research institutions operate measuring stations in the North Sea and Baltic Sea and conduct surveys on various research and monitoring questions and tasks. This is associated with different requirements for accessibility or avoidance of disturbances.

Within the framework of the German Small-scale Bottom Trawl Survey (GSBTS), several standard survey areas ("boxes") in the North Sea and the Baltic Sea have been sampled by the Thünen Institute of Sea Fisheries (with the vessels SOLEA, Walter Herwig III) since 1987.

The TI investigates small-scale abundance and distribution patterns of demersal fish in the North Sea. For this purpose, 12 standard study areas ("boxes"), each 10 x 10 nautical miles in size, are surveyed annually with a standardised bottom trawl. The available data set forms an important basis for assessing long-term changes in the demersal fish fauna of the North Sea caused by natural (e.g. climatic) influences or anthropogenic factors (e.g. fishing).

The GSBTS samples bottomfish communities on a small scale using a standardised bottom trawl with a high stowage otter trawl type GOV. In parallel, the epibenthos (by means of a 2 m beam trawl), the infauna (by van Veen grab) and sediments are investigated, and hydrographic and marine chemical parameters are recorded in regionally typical habitats.

The following impacts on the marine environment are possible through the use of marine scientific research.

Table 23: Effects and potential effects of marine research (t= temporary).

Use	Effect	Potential impact	Protected goods																
			Benthos	Fish	Seabirds and resting birds	Migratory birds	Marine mammals	Bats	Plankton	Biotope types	Biodiversity	Floor	Area	Water	Air	Climate	Man/ Health	Cultural and material assets	Landscape
Marine research	Removal of selected species	Reduction of stocks		x															
	Physical disturbance by trawls	Harm/ damage By-catch	x	x						x		x						x	

3.6.1 Floor

The various marine research activities are associated with different environmental impacts depending on the type of methods and equipment used. Of particular importance for the soil as a protected resource are fisheries research activities, which can lead to physical disturbance of the seabed surface by trawl nets (see Fisheries Chapter 3.5.1). Bottom trawl fish usually penetrate the seabed on sandy soils to a depth of a few millimetres to centimetres.

It cannot be ruled out that grain sorting takes place on the seabed as a result of regular fishing, with formerly stirred-up fine sandy sediment accumulating on the seabed surface. This is contradicted by the fact that due to natural sediment dynamics, especially during intensive sand rearrangements during storms, the upper decimetres are completely mixed and thus a largely natural sediment composition is restored. This also means, among other things, that drag marks are generally not permanently observed on the predominantly sandy seabeds of the EEZ.

The near-bottom formation of turbidity plumes and possible release of pollutants from the sediment is negligible due to the generally relatively low proportion of silt and clay and the low concentrations of heavy metals.

The impacts on soil as a protected resource are independent of the non-implementation or implementation of the plan.

3.6.2 Benthos and biotope types

The various activities of marine research are associated with different environmental impacts depending on the type of methods and equipment used. Sampling can lead to varying degrees of damage and even death of individual benthic organisms. Similarly, the use of specific methods and equipment can lead to a small amount of material emissions of various kinds. In principle, it can be assumed that intensive research activities, especially on sensitive species or in sensitive habitats, can lead to significant environmental impacts. Overall, however, it can be assumed that marine research is geared towards minimising environmental impacts and is adapted to the requirements for the protection of endangered species.

In summary, the main impacts of the research actions on the marine macrozoobenthos are as follows:

- Local, temporary damage or loss of individuals due to sampling.
- local, temporary impact due to the increase in pollutant inputs.

The above-mentioned impacts on benthic communities and biotope types occur independently of the non-implementation or implementation of the plan.

3.6.3 Fish

The various marine research activities are associated with different impacts on fish fauna depending on the type of methods and equipment used. Sampling, for example, can lead to varying degrees of harm and even death to fish. The removal of fish could contribute to the decline of some species. Intensive research activities, especially on sensitive species or in sensitive habitats, could lead to significant environmental impacts. In general, however, marine research in the North Sea serves to identify negative developments in the ecosystem at an early stage and to make targeted recommendations. In the long term, diverse marine research can thus make an important contribution to the conservation of the marine environment.

The above-mentioned impacts of marine research on fish fauna occur regardless of whether the plan is not implemented or is implemented.

3.6.4 Marine mammals

The potential impacts of research on marine mammals are: small-scale and temporal impacts from bycatch in fisheries research; local temporal impacts from fishing vessels; and sub-regional temporal impacts from seismic and other sound-intensive research activities.

Non-implementation of the plan would not affect the existing or described impacts of marine research on harbour porpoise, harbour seal and grey seal.

3.6.5 Seabirds and resting birds

Marine research can have different impacts on seabirds and resting birds, depending on its objectives and design. In the case of fisheries research, bycatch and discard effects are the main concerns. The use of vessels can cause visual disturbance effects on species sensitive to disturbance, triggering avoidance behaviour. Indirectly, fisheries research can affect the marine food chain and influence the food supply for seabirds and resting birds.

Overall, impacts of marine research can be described as small-scale and limited to the duration of the research activity.

Due to the small-scale, time-limited activities of scientific research, significant impacts on seabirds can be ruled out with certainty.

The above-mentioned impacts on seabirds and resting birds occur independently of the non-implementation or implementation of the plan.

3.6.6 Migratory birds

The various marine research activities are associated with different environmental impacts depending on the type of methods and equipment used. For migratory birds, short-term and small-scale visual and acoustic disturbance effects can be relevant. However, these effects are small-scale and limited in time.

In addition, research activities may be associated with the installation of tall structures. These could conceivably have an impact at night in poor weather conditions when migratory birds are attracted by illuminated structures and could potentially collide.

The above-mentioned impacts on seabirds and resting birds occur independently of the non-implementation or implementation of the plan.

3.6.7 Bats

Research activities may involve the installation of tall structures that may have an attracting effect on bats through lighting.

If the plan is not implemented, the same impacts on bats may occur as if the plan were implemented.

3.6.8 Cultural assets and other material assets

When assessing the impacts of marine research or archaeological research, a distinction must be made between intrusive and non-intrusive research methods. Non-intrusive research methods, such as geophysical or acoustic mapping of the seabed, are generally not expected to have negative impacts. On the contrary, the results could also be used for research into the underwater cultural heritage.

When taking soil samples by coring, archaeologically relevant layers could be pierced, but their disturbance is insignificant due to the small scale. Sampling by excavator grabs may interfere more with the potential cultural property, but an information gain in the recording and reporting of archaeological finds is usually of higher value than the destruction would be problematic.

3.7 Nature conservation

The German EEZ represents a special natural area with a great diversity of species, biotic communities and habitat-typical processes.

In contrast to the other types of use, marine nature conservation is not a use in the narrower sense, but rather an existing basic area-wide spatial function claim that must be taken into account when other uses are claimed. The transboundary character of marine nature should also be emphasised. Marine nature and all related processes are part of a large-scale, dynamic system, without being bound by political borders.

With the legal ordinances of 22.09.2017, the already existing bird protection or FFH areas in the German EEZ were included in the national area categories and declared nature conservation areas in accordance with sec. 57 BNatSchG. Within this framework, they were partly regrouped. Thus, through the Ordinance on the Establishment of the Nature Reserve "Sylt Outer Reef - Eastern German Bight" (NSGSylV), the Ordinance on the Establishment of the Nature Reserve "Borkum Riffgrund" (NSGBRgV) and the Ordinance on the Establishment of the Nature Reserve "Doggerbank" (NSGDgbV), the nature reserves "Sylt Outer Reef - Eastern German Bight", "Borkum Riffgrund" and "Doggerbank" now exist.

Art. I 6 para. 1 of the Habitats Directive provides that Member States shall establish the necessary conservation measures and, where appropriate, prepare management plans (also called management plans). On 17.11.2017, BfN initiated the participation procedure for the management plans for the nature conservation areas in the German EEZ of the North Sea. All three management plans entered into force on 13.05.2020.

In addition to the nature conservation areas legally established by ordinance on 22 September 2017, the nature conservation requirements of the Federal Ministry for the Environment, Nature

Conservation and Nuclear Safety (BMU) resulting from the position paper of the division of the Federal Ministry for the Environment on the cumulative assessment of diver habitat loss due to offshore wind farms in the German EEZ of the North Sea and Baltic Sea of 2009 (main distribution area of the divers) and the concept for the protection of harbour porpoises from noise pollution during the construction of offshore wind farms in the German North Sea, noise protection concept of 1. December 2013 (main concentration area of harbour porpoises in the German EEZ from May to August). On this basis, the assessment criteria under species protection law were adjusted.

3.7.1 Floor

Through the national marine protected areas and the associated management plans, the favourable conservation status of habitat types such as "reefs" and "sandbanks" and biotope types such as the "KGS grounds" is to be achieved or maintained, among other things. This can also strengthen the protection of the low occurrences of coarse sediments (gravel, coarse sand), residual sediments and blocks in the German EEZ. In addition to measures to reduce the negative impacts of trawl fishing and sand and gravel extraction, other planned measures in the management plans are also associated with positive effects for the protected resource of soil, such as the reduction of impairments due to pollutant inputs.

As the spatial plan supports nature conservation by identifying priority areas, the protection of the seabed in the national marine protected areas would probably be less well ensured if the plan were not implemented.

3.7.2 Benthos and biotope types

The aim of the designated nature conservation areas and the conservation area measures is to safeguard the ecological functions of the protected species and habitats. Among other things, the target states for the FFH habitat types "reefs" and "sandbanks" with the corresponding benthic communities are to be achieved through appropriate measures. If the plan were not implemented, the positive effects of designating nature conservation areas as priority areas on benthic habitats would probably be less well guaranteed.

3.7.3 Fish

Marine protected areas of sufficient size could have a positive impact on fish populations and counteract the overexploitation of fish stocks.

The nature reserves "Borkum Riffgrund" and "Sylt Outer Reef - Eastern German Bight" are of particular importance for fish. The Habitats Directive species finback uses both marine protected areas as feeding habitats. For the FFH species river lamprey, the nature reserve "Sylter Außenriff - Östliche Deutsche Bucht" represents a feeding and migration area. The food availability in the nature reserve "Sylter Außenriff - Östliche Deutsche Bucht" is at times very high due to frontal and upwelling areas and probably also attracts potential host fish for the parasitic river lamprey. Overall, diverse fish species, whether FFH, Red List (THIEL et al. 2013) or commercial species, can occur in and benefit from marine protected areas. Previous studies showed an increase in abundance, biomass and species diversity within marine protected areas of sufficient size and protection status ("no-take areas"/ "no-trawl areas") compared to unprotected areas (CARSTENSEN et al. 2014, MCCOOK ET AL. 2010, STOBART ET AL. 2009). In addition, the age-length structure could change towards older larger individuals that show increased reproduction (CARSTENSEN et al. 2014). The result would be improved recruitment and thus increased productivity of fish stocks. However, there is a need for research on the effects of nature reserves on the fish community in the North Sea. A direct transfer of the available international findings is only possible to a limited extent, as important influencing variables, such as other uses in the protected area or climatic changes, are largely not taken into account. In general, according to scientific findings, the benefits for fish fauna are higher in nature reserves without any uses compared to partially protected areas (LESTER & HALPERN 2008, Sciberas ET al. 2013). In German marine protected areas, other uses such as fishing or resource extraction are partly permitted. However, the impacts of these uses on the species protected under the Protected Areas Ordinance (Finte and Flussneunauge) have been assessed as low to negligible (BFN 2017). Overall, according to current knowledge, marine protected areas in the North Sea can have a significant positive impact on the fish community.

3.7.4 Marine mammals

The protection of endangered and characteristic species and habitats is of great importance with regard to the preservation of healthy marine ecosystems and marine biodiversity. The expansion of the Natura2000 network and the designation of the nature reserves "Borkum Riffgrund", "Sylter Außenriff - Östliche Deutsche Bucht" and "Doggerbank" contribute to the conservation or restoration of populations of protected and characteristic species and their habitats.

3.7.5 Seabirds and resting birds

The protection of nature and habitats contributes to the conservation or restoration of populations and habitats. In this context, nature reserves and other areas of special importance have an important function in maintaining ecological connectivity between the different levels of the food web. Adequate protection of habitats also serves the protection of endangered species and species conservation in particular.

3.7.6 Migratory birds

Many bird species migrating across the German North Sea stop over in the EEZ on their way to their winter or breeding grounds. The general impacts of nature conservation on seabirds and resting birds described in Chapter 3.7.5therefore also apply accordingly to many migratory bird species.

3.8 National and alliance defence

The realisation of national defence and alliance obligations includes training, exercise and testing activities. In the EEZ, the military exercise areas are established on the basis of the United Nations Convention on the Law of the Sea.
In the German coastal seas and the German EEZ in the North Sea and Baltic Sea, special exercise areas in and over the sea have been established for the armed forces in the past.
The exercise requirements of the German naval and maritime air forces as well as the German air and land forces in and over the sea have increased in recent years. In addition to training and exercises for basic operations, continuous operations and foreign missions, military activities include the testing of new procedures and systems.

The exercise areas can be subdivided according to the type of exercises taking place there and can involve airspace, the water surface or areas under water.

The following types of training areas are available to the armed forces in the German EEZ of the North Sea and Baltic Sea: Artillery firing areas, torpedo firing areas, submarine diving areas, (air) danger areas over sea from sea level are available.

In the areas, the navy and the air force practise firing with barrel weapons (machine gun, shipboard gun) against air and sea targets, with missiles and with light and heavyweight torpedoes. Furthermore, the use of electronic countermeasures or decoys, mine laying and mine hunting (sonar use) are practised.

The navy conducts firing exercises with different types of ammunition throughout the year. A detailed list is subject to military secrecy. In principle, firing and blasting can be carried out anywhere at sea if the necessary conditions (water depths, weather conditions, sea area checked and free of vehicles) are available. Firing exercises are predominantly conducted within the boundaries of the artillery firing ranges. Exercises outside these areas are limited to exceptions with single shots. The German Navy does not conduct regionally related evaluations for consumption of different ammunition types and calibres. In general, practice ammunition consisting of metal and concrete as well as ammunition that self-destructs in the air is used in the artillery firing ranges. Apart from a few exceptions, the airborne combat units of the German Air Force only use practice ammunition in the training areas.

During firing exercises with barrel weapons, missiles and torpedoes in "live" fire, only small residues are produced. When missiles are used, - they or their seeker heads are recovered immediately after the end of the exercise, provided they do not detonate. When firing practice ammunition with barrelled weapons, the metal projectiles filled with a gypsum-concrete mixture remain in the exercise area. After firing practice torpedoes, they are retrieved and returned to the depot.

Some areas are subject to voluntary restrictions on use; for example, underwater blasting is not carried out in the exercise areas during certain periods to minimise negative impacts on fisheries and marine mammals.

For military training operations, regulations are in place to protect marine mammals during the use/generation of underwater sound, both during the use of sonars and underwater blasting. The following measures are foreseen:

- Obtain information on the possible presence of marine mammals.
- Visual and acoustic monitoring of hazard areas prior to blasting.
- Carry out deterrence measures before blasting.
- If marine mammals are sighted within two nautical miles, blasting will be suspended until the animals have moved away from the area.

The following table shows the effects of the exercise areas on national and allied defence and potential impacts on the protected goods.

Table 24: Effects and potential effects of national and alliance defence (t= temporary).

Use	Effect	Potential impact	Protected goods																
			Benthos	Fish	Seabirds and	Migratory birds	Marine mammals	Bats	Plankton	Biotope types	Biodiversity	Floor	Area	Water	Air	Climate	Man/ Health	Cultural and mate-	Landscape
National defence	Underwater sound	Impairment/ scare effect		x t			x												
	Introduction of dangerous substances	Impairment	x	x	x		x		x	x	x	x		x			x		
	Collision risk	Collision					x												
	Surrounding water sound	Impairment/ scare effect			x	x		x									x		
	Bringing in rubbish	Impairment	x	x					x					x			x		

3.8.1 Soil

Military activities in connection with national and alliance defence can result in the input of pollutants through the associated shipping (see also Chapter 3.1.1).

Another possible source of pollutants that can lead to soil and water contamination is the ammunition residues left in the shooting areas or the remains of blasting operations.

The general effects of national and alliance defence on the protected resource of soil arise independently of the implementation or non-implementation of the plan.

3.8.2 Benthos and biotopes

Due to the ammunition residues remaining in shooting areas, there may be a release of pollutants, which can affect benthic communities in their biotopes.

The effects of national and alliance defence arise independently of the non-implementation or implementation of the plan.

3.8.3 Fish

Fish fauna could be affected in particular by underwater sound and the introduction of hazardous substances by military uses. Depending on the level, underwater sound can lead to scaring effects (ship traffic) and even the death of individual fish (e.g. detonation). For detailed effects of underwater sound on fish fauna, see Chapters 3.2.3and 3.1.3 In general, military activities such as shooting exercises or submarine manoeuvres are limited in space and time.

Further adverse effects from military incidents could result from the release of toxins from the estimated 1.3 million tonnes of munitions dumps and wrecks located on the seabed of the North Sea. Insights into the extent to which progressive corrosion promotes the release of toxic substances and how these affect the health of fish are scarcely known. Initial results from the Thünen Institute of Fisheries Ecology showed no difference in the health status of cod from the main dumping area for chemical warfare munitions east of Bornholm compared to an uncontaminated reference area (Lang et al. 2017). Nevertheless, increased pollutant accumulation in fish cannot be ruled out. There is a need for research on effects on different species and life stages, reproductive capacity or the spread of toxic substances via the food web.

The above-mentioned impacts of the Land and Alliance Defence on fish fauna occur irrespective of the non-implementation or implementation of the plan.

3.8.4 Marine mammals

For marine mammals, possible impacts from military exercises involving the input of underwater sound are possible. In particular, sonar and blasting are relevant. Studies in marine areas with deep waters (>1000 m) have shown that the use of military sonars has led to disturbance, injury and even stranding of cetaceans (Azzellino et al., 2011, Zirbel et al., 2011). Blasting of old munitions also has the potential to injure and kill animals if no protective measures are taken. For this reason, protective measures are regularly taken during blasting operations, including observation of the immediate vicinity and deterrence.

The general impact of land defence on marine mammals does not differ between non-implementation or implementation of the plan.

3.8.5 Avifauna

General impacts of national defence on birds can be caused in particular by visual disturbance from ship or low-flying air traffic. In general, military activities, such as shooting exercises or submarine manoeuvres, are limited in space and time. In addition, direct and indirect impacts, e.g. via the food chain, are possible through the introduction of hazardous substances, such as the release of toxic substances.

The general effects of land defence on birds do not differ between non-implementation and implementation of the Plan.

3.9 Other uses without spatial specifications

No spatial specifications are made for other uses.

3.9.1 Leisure

3.9.1.1 Fish

Impacts of recreational activities on fish fauna are particularly expected from sea angling and recreational traffic. In 2013/2014, recreational fishing accounted for about 1.4 million days of active fishing in the German Bight, 10% of which was in the North Sea (HYDER et al. 2018). Catches by recreational fisheries do not usually have to be reported to government institutions from the marine sector, so no scientifically usable catch statistics exist for the North Sea (BFAFi 2007).

For individual species, the European Fisheries Policy regulates the extraction for recreational fishing (EU, 2020). Catches of sea bass and salmon by recreational fisheries are significant throughout the North Sea, so ICES considers these catches for stock assessments (ICES 2018a). The removal of individual fish by anglers and hobby fishermen could contribute to the decline of the species caught, with particular negative effects on the stock situation of endangered species. These effects are partially mitigated by EU regulations. The extent to which the fish community in the North Sea is affected and the impact of fishing mortality on individual stocks cannot be estimated at present. Further impacts from recreational traffic are caused by underwater noise (see Chapter 3.1.3details) and by muck discharges (see Chapter 3.5.3).

The above-mentioned impacts of recreational activities on fish fauna occur regardless of whether the plan is not implemented or is implemented.

3.9.1.2 Marine mammals

Impacts may occur to marine mammals, particularly from recreational activities that involve input of underwater sound or disturbance of seal resting sites (HERMANNSEN et al., 2019.

The aforementioned impacts of recreational activities on marine mammals occur regardless of whether the plan is not implemented or is implemented.

3.9.1.3 Avifauna

General effects of recreation on birds may occur, particularly from visual disturbance caused by recreational traffic. In addition, there may be direct and indirect effects through the food chain from the disposal and introduction of litter into the marine environment.

The general effects of recreation on birds do not differ between non-implementation and implementation of the Plan.

3.10 Interactions

It is assumed that the interactions between the protected goods will develop in the same way if the plan is not implemented as if it is implemented. At this point, reference is made to Chapter 2.18

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

In the following, the description and assessment of the environmental impacts of the plan concentrates on the protected assets for which significant impacts cannot be ruled out from the outset through the implementation of the maritime spatial plan.

According to Section 8 ROG, the likely significant impacts of the ROP on the protected goods must be described and assessed. In doing so, the maritime spatial plan sets a framework for downstream planning levels.

The protected assets for which a significant adverse effect could already be ruled out in the previous chapter 2 are not taken into account. This concerns the protected goods plankton, air, cultural heritage and other material goods, as well as the protected good humans, including human health.

Possible impacts on biodiversity are dealt with under the individual biological assets. Overall, the protected goods listed in sec. 8 para. 1 ROG are examined before the species protection and site protection assessments are presented.

The basic impacts of the ROP's specifications on the protected resource "land" - in particular land use by the uses - are summarised in Chapter 2.1. Due to the following points, it is only possible to assess the extent to which the ROP specifications have an impact on the site as a protected resource by looking at all the uses together:

- Temporally and spatially overlapping uses possible
- Mostly no 100% permanent land consumption of a use
- Not all uses, unlike on land, actually consume land in the sense of seabed.

In the ROP itself, such a summary consideration was carried out in the context of the specifications on uses with regard to the protected resource of land. For this reason, the protected resource of land will not be considered further in the following, which avoids having to repeatedly discuss the fundamental impacts and specifications of the ROP - in the context of land use.

4.1 Shipping

In the maritime spatial plan, priority areas for shipping SN1 to SN18 are defined in the North Sea EEZ.

In order to assess the environmental impacts of shipping, it is necessary to examine which additional impacts can be attributed to the specifications in the maritime spatial plan.

The designated priority areas for shipping are to be kept free of constructional use. This control in the ROP will reduce collisions and accidents. Due to the specifications in the ROP, the traffic frequency in the priority areas is expected to increase due to displacement and bundling effects. Vessel movements on the shipping routes SN1 to SN18 vary greatly, with over 15 vessels per km² per day in some cases on the busiest route SN1, and mostly around 1-2 vessels per km² per day on the other, narrower routes (BfN 2017).

The BSH has commissioned an expert report on the traffic analysis of shipping traffic, where up-to-date evaluations are expected.

The presentation of general impacts from shipping is presented in Chapter 2 as a pre-impact, especially for birds and marine mammals. The impacts from service transport to the wind farms are dealt with in the chapter on wind energy.

The designation of priority areas for shipping serves as a precautionary measure to minimise risks. In addition, it must be taken into account that freedom of navigation is to be ensured according to UNCLOS and the possibility of regulation by the IMO in international conventions is significantly stronger than in the ROP.

4.1.1 Floor

As the impacts of shipping on the seabed occur independently of the implementation or non-implementation of the Plan, the ROP provisions do not result in any impacts other than those described in Chapter 3.1.1. The principle of the ROP to reduce impacts on the marine environment through best environmental practice in accordance with international conventions can contribute to the avoidance of pollutant inputs.

In summary, it can be stated that significant negative impacts on the seabed can be ruled out due to the ROP's stipulations on shipping.

4.1.2 Water

The impacts of shipping on the protected resource water are independent of the implementation of the ROP. In this respect, significant impacts of the specifications for shipping on the protected resource can be ruled out.

4.1.3 Benthos and biotope types

With regard to the use of shipping, there are no further specific effects of the ROP specifications on the benthos or biotope types compared to the general effects of use described in Chapter 3.1.2 Significant impacts on benthic communities and biotopes due to the ROP provisions on shipping can therefore be ruled out.

4.1.4 Fish

The effects of shipping on fish are described in Chapter 3.1.3

National spatial planning is subject to the freedoms of the UN Convention on the Law of the Sea, including freedom of navigation. Furthermore, shipping is regulated in international conventions by the IMO. The area designations for navigation in the ROP are therefore not expected to have any additional or significant impacts on fish fauna.

4.1.5 Marine mammals

The priority areas for shipping are based in particular on existing shipping routes identified in the procedure for updating the ROP. These designations serve to keep important shipping routes free of incompatible uses - in particular construction - in order to reduce impacts. The designation of priority areas for shipping does not have any direct effect on concentrating and directing shipping traffic. Shipping can continue to use the entire lake area in the future. In this respect, the designation of areas for shipping has no additional impact on marine mammals as a whole compared to the current situation and the zero option.

The ROP also contains statements on the reduction of the impact on the marine environment by observing the IMO regulations and best environmental practice in accordance with the OSPAR and HELCOM Conventions as well as the respective state of the art in shipping. This avoids negative impacts on the protected goods.

On the basis of the above statements and the presentations in Chapter 3, it can be stated for the SEA that no significant impacts on marine mammals are to be expected as a result of the specifications for shipping in the ROP, but rather that adverse impacts are avoided in comparison with the non-implementation of the plan, in particular by reducing conflicts of use.

4.1.6 Seabirds and resting birds

The general impacts of shipping on seabirds and resting birds are described in Chapter 3.1.5

The spatial planning designations of priority areas for shipping map the main traffic flows in the EEZ, in which shipping is given priority over other spatially significant uses. This spatial planning objective serves in particular to prevent conflicts (collisions) with offshore wind farms and, as a consequence, to prevent potential accidents affecting the marine environment and thus also seabirds and resting birds. The designations for shipping do not automatically lead to an increase in traffic volume in the priority areas, as shipping enjoys special freedom under Article 58 UNCLOS and is therefore not bound to certain routes. However, certain displacement and bundling effects are to be expected.

Additional or significant impacts of the specifications for navigation on seabirds and resting birds can thus be excluded with the necessary certainty.

4.1.7 Migratory birds

With regard to the use of shipping, there are no further specific impacts of the ROP's specifications compared to the general impacts described in Chapter 3.1.6 Significant impacts on migratory birds due to the ROP's provisions on shipping can be ruled out with the necessary degree of certainty.

4.1.8 Bats

With regard to the use of shipping, there are no further specific impacts of the ROP provisions compared to the general impacts described in Chapter 3.1.7 Significant impacts on bats due to the ROP provisions on shipping can be ruled out with the necessary certainty.

4.1.9 Air

Shipping causes pollutant emissions. These can have a negative impact on air quality. However, this is independent of the implementation of the ROP.

4.1.10 Climate

No significant impacts on the climate are expected as a result of the specifications on shipping.

4.2 Wind energy at sea

The ROP contains specifications for priority and reserved areas for wind energy. In particular, the area specifications of the sectoral plan for wind energy - the FEP 2019/Draft FEP 2020 - are taken into account. With the priority areas EN1 to EN3 and EN6 to EN8, the area designations N-1 to N-3, N-6 to N-8 of the FEP 2019 are adopted as priority areas. The areas of the FEP 2019 N-9 to N-13 have been extended in a north-westerly direction and are designated as priority areas EN9 to EN13 in the ROP in the extended form. In the case of areas EN4 and EN5, the areas shown under examination in the FEP 2019 are established as reserved areas. Areas EN14 to EN19 are defined as reserved areas. In the following, the area designations are only examined insofar as they have additional impacts and have not already been fully addressed in the Strategic Environmental Assessment (North Sea Environmental Report) for the FEP 2019/Draft FEP 2020.

Various impacts on the marine environment may arise in connection with the construction and operation of wind turbines and ancillary facilities in the areas, including local habitat loss due to permanent surface sealing, scouring and barrier effects and a resulting loss of habitat for avifauna. Also to be considered are potential impacts from maintenance and service traffic.

4.2.1 Soil

The construction and operation of offshore wind turbines has more local impacts on the soil as a protected resource (see Chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**), which occur independently of the implementation of the spatial development plan. However, the designation of priority and reserved areas for the use of offshore wind energy reduces negative impacts on the seabed by coordinating the areas eligible for the construction of wind turbines and thus reducing land take. No wind turbines and platforms are planned in the marine nature conservation areas, in particular due to legal requirements of the WindSeeG. In addition, the ROP contains specifications for spatially co-ordinated laying and, if necessary, a smaller number of cable systems, the lowest possible number of cable crossings and gentle laying procedures.

The expansion of wind energy within the priority areas is already regulated in detail in the FEP 2019. This also contains the spatially coordinating specifications that are positive for the marine environment.

The designation of the reserved areas is likely to lead to the installation of wind turbines in these areas, which will result in an additional impact on the seabed despite the positive coordinating effect of the ROP. However, significant impacts in zones 4 and 5 are not a concern, as the impacts will be temporary and mostly very small-scale. In these areas, the seabed surface consists of fine sands with, in part, appreciable contents of silt and clay. In the areas with increased fine grain content, the impact will increase slightly during the construction phase of the facilities due to re-suspension of sediment and turbidity plumes. Local sealing of the seabed will be very low, as in the existing wind farm areas.

Finally, it should be noted that the specifications for wind energy in the maritime spatial plan involve an expansion of the area for wind energy use. However, no significant negative impacts on soil as a protected resource are to be expected. On the contrary, compared with non-implementation of the plan, adverse impacts can be avoided through the coordinating spatial specifications.

4.2.2 Benthos

Wind energy use may have an impact on macrozoobenthos. These impacts apply equally to all designated areas for wind energy use.

The North Sea EEZ is not of outstanding importance with regard to the species inventory of benthic organisms.

Construction-related: The deep foundations of the wind turbines and platforms cause disturbance of the seabed, sediment turbulence and the formation of turbidity plumes. This can lead to impairment or damage to benthic organisms or communities in the immediate vicinity of the turbines for the duration of construction activities. During the construction of the facilities, the re-suspension of sediment in particular leads to direct impacts on the benthic community. Turbidity plumes are to be expected during the foundation work for the facilities. However, the concentration of suspended material usually decreases very quickly with removal. Due to the prevailing sediment characteristics, the released sediment will settle quickly.

Changes in the benthic community may occur due to the sealing of surfaces, the introduction of hard substrates and the change in flow conditions around the facilities. In the area of the facilities and the associated scour protection, there will be surface sealing/land use and thus a complete loss of soft-bottom macrozoobenthic habitats.

In addition to habitat losses or habitat changes, new off-site hard substrate habitats are created. This can influence the soft-bottom fauna in the immediate vicinity. According to KNUST et al. (2003), the introduction of artificial hard substrate into sandy soils leads to the colonisation of additional species. The recruitment of these species will most likely come from the natural hard substrate habitats, such as superficial boulder clay and stones. Thus, the risk of a negative impact on the benthic sandy soil community by species untypical of the area is low.

According to current knowledge, operational impacts of the wind turbines and platforms on the macrozoobenthos are not to be expected.

On the basis of the above statements and representations, the result of the SEA is that, according to current knowledge, no significant impacts on the benthic ecosystem are to be expected from the designation of areas for wind energy in the ROP. Overall, the impacts on the benthic ecosystem are assessed as short-term and small-scale. Only small-scale areas outside protected areas are affected and, due to the mostly rapid regeneration capacity of the benthic organism populations with short generation cycles and their widespread distribution in the German Bight, rapid recolonisation is very likely.

4.2.3 Biotope types

Possible impacts of wind energy use on biotope types may result from direct use of protected biotopes, possible overlap due to sedimentation of material released during construction, and potential habitat changes.

A significant construction-related impact on protected biotopes is not to be expected for areas EN1 to EN18, as protected biotope structures pursuant to sec. 30 BNatSchG are to be avoided as far as possible in the context of the specific approval procedure. Due to the prevailing sediment characteristics in the areas in which protected biotopes are expected to occur, impairments due to sedimentation are likely to be small-scale, as the released sediment will settle quickly.

For site EN19, which is located on an occurrence of the biotope type "sublittoral sandbanks" protected under sec. 30 para. 2 no. 6 BNatSchG, it must be ensured that the orientation values for relative and absolute area loss according to LAMBRECHT & TRAUTNER (2007) and Bernotat (2013) are not exceeded.

Permanent habitat changes result from the installation, but these are limited to the immediate area of the installations. The artificial hard substrate provides new habitat for benthic organisms and can lead to a change in species composition (SCHOMERUS et al. 2006). These small-scale areas are not expected to have a significant impact on the biotope types. In addition, the recruitment of species is very likely to occur from the natural hard substrate habitats, such as superficial boulder clay and stones. Thus, the risk of a negative impact on the benthic soft-bottom community by species untypical of the area is low.

According to current knowledge, operational impacts of wind energy use on biotopes are not to be expected.

4.2.4 Fish

In the priority areas for wind energy use, the typical demersal fish community of sandy soils of the southern North Sea was consistently found. According to the current state of knowledge, the construction, foundations and operation of the wind turbines are not expected to have any significant impact on the population level in all priority areas. Detailed information on the impacts of offshore wind energy on fish fauna is described in Chapter 3.2.3

The designation of priority and reserved areas for offshore wind energy in the ROP offers the possibility of sustainable development with as few conflicts of use as possible. The protection requirements of the marine environment are coordinated by the designations, thus avoiding disturbance of valuable habitats such as nature conservation areas.

On the basis of the current state of knowledge, it can therefore be stated for the SEA that no additional or significant impacts on the protected resource fish are to be expected as a result of the area designations for wind energy in the ROP, compared to the non-implementation of the plan.

4.2.5 Marine mammals

The overall impact of wind turbines on marine mammals due to the designation of priority areas for wind energy is expected to be insignificant. This also applies to a cumulative assessment.

The function and importance of the priority areas in the German EEZ of the North Sea for harbour porpoises were assessed in Chapter 2.8according to current knowledge.

By designating priority and reserved areas for offshore wind energy extraction outside nature conservation areas, disturbances within valuable habitats of particular importance as feeding and breeding grounds are avoided. The designation of the harbour porpoise reservation area also enables better protection during the sensitive period through strict measures ordered in the downstream approval procedures.

In addition, provisions were made for the protection of the marine environment with regard to the consideration of best environmental practice in accordance with the OSPAR and Helsinki Conventions as well as the state of the art. In this context, regulations on the avoidance and reduction of negative impacts on marine mammals caused by the construction and operation of wind turbines, in particular in the form of requirements for noise minimisation, which may also provide for the coordination of construction work on simultaneously constructed projects, are to be adopted at the approval level. This is in line with current licensing practice. On the basis of the function-dependent significance of the priority areas for wind energy and the principles contained in the ROP, as well as the measures ordered in the downstream approval procedures and taking into account the current state of science and technology in the reduction of impulsive noise inputs, significant impacts on harbour porpoise, harbour seal and grey seal can be ruled out. Direct disturbances of marine mammals at the individual level due to sound emissions during the construction phase, especially during pile driving, are to be expected on a regional and temporary basis. However, due to the high mobility of the animals and the above-mentioned measures to be taken to avoid and reduce intensive sound emissions, significant impacts can be ruled out with a high degree of certainty.

This also applies under the aspect that shipping could have an impact on marine mammals sensitive to disturbance, as these effects are only very short and local. Sediment plumes are largely expected to occur on a local and temporal scale. Habitat loss for marine mammals could thus occur on a local and temporal scale. Impacts from sediment and benthic changes are insignificant for marine mammals, as they forage for prey organisms predominantly in the water column in widespread areas. Effects on the population level are not known and are rather unlikely due to predominantly short-term and local effects in the construction phase.

Significant impacts of the wind turbines in the priority areas on marine mammals during the operational phase can also be ruled out with certainty according to the current state of knowledge. The investigations carried out as part of the operational monitoring for offshore wind farms have so far not provided any indications of avoidance effects on harbour porpoises caused by wind farm-related shipping traffic. So far, avoidance has only been observed during the installation of the foundations, which may be related to the large number and varying operating conditions of vehicles at the construction site.

In summary, the designation of priority areas outside the main feeding and nursery areas for harbour porpoises indirectly serves to protect the species. The priority areas for nature conservation contribute to the protection of open spaces, as they exclude uses that are incompatible with nature conservation. This reduces threats to harbour porpoises in important feeding and breeding grounds. The area designations also have no negative impacts on seals and grey seals.

On the basis of the above statements and the illustrations in Chapter 3the SEA concludes that the identification of priority areas for wind energy in the spatial plan for the German EEZ of the North Sea is not expected to have any significant impacts on marine mammals, even from a transboundary perspective, but rather avoids adverse impacts compared to the non-implementation of the plan.

4.2.6 Seabirds and resting birds

The general impacts of the offshore wind series on seabirds and resting birds are described in Chapter 3.2.5

Some of the priority areas are located in areas where offshore wind farm projects have already been realised or are in the process of being realised (EN1 to EN3, EN6 to EN8). Other priority areas in which no projects have yet been implemented are spatially connected to already developed areas (EN9 to EN13), so that a comparable function as resting and feeding habitat can be assumed for these areas, taking into account the respective species-specific habitat requirements, spatial and temporal distribution patterns and species-specific behaviour towards OWPs (cf. Chapters 2.9.2.5and 3.2.5). The designation of reserved areas for wind energy takes into account, among other things, areas such as EN4 and EN5 for which conflicts of use have already been identified in the FEP 2019 and FEP 2020 and which have been placed under review for possible subsequent use (BSH 2019, BSH 2020a).

The extended priority area for wind energy EN13 is directly adjacent to the priority area for common divers. Based on the findings on the avoidance behaviour of common divers towards offshore wind energy presented in 3.2.5must be assumed, according to the current state of knowledge, that the wind farm projects to be realised on EN13 will have a shying effect on the priority area for common divers to the extent identified. The same assumptions apply to the conditional priority area EN13-North, insofar as the area becomes a priority area for wind energy from 01.01.2030. Therefore, the extent to which avoidance and mitigation measures must be used must be examined in the individual procedure for the specific turbines applied for.

The designation of areas EN14 to EN19 as reserved areas for wind energy takes into account, among other things, the lower level of knowledge about the species spectrum and distribution of seabirds in this area of the EEZ.

The designations for wind energy may lead to a spatial increase in shipping traffic in some subareas of the EEZ due to the applicable navigation regulations. However, it can be assumed that this concentration will take place in traffic areas that already have a higher level of shipping activity.

Current findings from studies confirm the scaring effect on divers triggered by wind farm-related shipping traffic (MENDEL et al. 2019, FLIESSBACH ET AL. 2019, BURGER ET AL. 2019). According to FLIEẞBACH et al. (2019), red-throated divers, black guillemots, black-throated divers, velvet scoters and red-breasted mergansers are among the most sensitive species to shipping traffic. The most common reaction is to fly up, even if the flight distances vary greatly.

According to current knowledge, the ROP specifications for wind energy in areas EN1 to EN12 do not have any additional or significant impacts on seabirds and resting birds. For the specifications for priority area EN13 and the conditional priority area EN13-North, this assessment can only be made in consideration of the overall plan assessment of the ROP (cf. Chapter 7).

4.2.7 Migratory birds

The general effects of offshore wind energy on migratory birds were described in Chapter 3.2.6

The designation of priority and reserved areas in spatial relation to each other and the safeguarding of open space in nature conservation areas will reduce barrier effects and collision risks in important feeding and resting habitats.

Based on the current state of knowledge, significant impacts on migratory birds as a result of the specifications can be ruled out with the necessary certainty, especially in comparison with the non-implementation of the maritime spatial plan.

4.2.8 Bats and bat migration

The general impacts of offshore wind energy on bats and the current state of knowledge on bat migration over the North Sea are described in Chapter 3.2.7

There are currently no indications that the spatial planning specifications have a significant impact on bats. The designation of priority and reserved areas in a spatial context and the safeguarding of open space in the nature conservation areas reduce barrier effects and protect important habitats.

4.2.9 Climate

The provisions on offshore wind energy are not expected to have any significant negative impacts on the climate.

The CO_2 savings associated with the expansion of offshore wind energy (cf. Chapter 1.8) can be expected to have a positive impact on the climate in the long term.

4.2.10 Landscape

As outlined in Chapter 3.2.10, the realisation of offshore wind farms in the priority and reserved areas identified by the ROP will have an impact on the landscape as a protected resource, as it will be altered by the erection of vertical structures and safety lighting. The extent of these visual impairments to the landscape caused by the planned wind turbines and platforms will strongly depend on the respective visibility conditions. Due to the considerable distance of the planned areas from the North Sea coast of more than 30 km, the turbines will only be perceptible from land to a very limited extent (HASLØV & Kjærsgaard 2000), and only under good visibility conditions. This also applies to night-time security lighting. Due to subjective perceptions as well as the basic attitude of the observer towards offshore wind energy, the vertical structures - which are atypical for a marine and coastal landscape - can be perceived partly as disturbing, but partly also as technically interesting. In any case, they bring about a change in the landscape and the character of the area is modified.

Beyond the coast, the visual impact on the landscape changes with greater spatial proximity to offshore areas. The type of use is decisive here. For example, the value of the landscape plays a subordinate role in industrial or transport use. For recreational use, however, as in the case of water sports enthusiasts and tourists, the landscape has a high value. However, direct use for recreation and leisure by recreational boats and tourist watercraft occurs only sporadically in the priority and reserved areas for the use of offshore wind energy.

As a result, the impairment of the coastal landscape by the planned wind energy plants in the German coastal EEZ can be classified as low. The provisions of the ROP can minimise the land required for the expansion of offshore wind energy through coordinated and harmonised overall planning and thus - compared to non-implementation of the plan - also reduce the impacts on the landscape as a protected resource.

Negative impacts on the landscape can be ruled out for the pipelines because they are laid in or on the seabed.

4.2.11 Cultural assets and other material assets

The general impacts of the planning, construction and operation of offshore wind turbines on cultural assets and other material assets are described in Chapter 3.2.11. Significant impacts of the spatial planning specifications can be ruled out with the necessary certainty.

4.3 Lines

The ROP defines the reserved areas for pipelines LN1 to LN15. Pipelines within the meaning of the ROP include pipelines and submarine cables. Submarine cables include cross-border power lines and connection lines for wind farms as well as data cables. So-called intra-park submarine cables are not included in this definition. addition, the ROP sets the goal of routing lines at the transition to the territorial sea through the border corridors GN1 to GN7, and at the transition to neighbouring states through the border corridors GN8 to GN19.

4.3.1 Floor

The impacts of the construction and operation of pipelines and submarine cables on the seabed described in Chapter 3.3.1arise independently of the provisions of the ROP.

The ROP makes statements regarding the reduction of pollution of the marine environment to be aimed for by taking into account best environmental practice in accordance with international conventions and the state of the art in science and technology. This can reduce adverse impacts on the marine environment. For example, when laying and operating pipelines, damage to or destruction of biotopes in accordance with sec. 30 BNatSchG must be avoided.

In addition, the designation of reserved areas for pipelines in the maritime spatial plan means that interactions between uses and cumulative effects on protected assets can be better assessed and predicted for existing and, above all, future plans.

Thus, no significant negative impacts are to be expected with regard to the soil as a protected resource as a result of the specifications for pipelines/submarine cables in the ROP. On the contrary, compared with non-implementation of the plan, adverse impacts are avoided, as the specifications in the plan aim to minimise the use of the seabed by reducing the number of cable routes and minimising the number of crossing structures.

4.3.2 Benthos

Pipelines may have an impact on macrozoobenthos. These impacts apply equally to all designated reserved areas for pipelines.

Construction-related: Possible impacts on benthic organisms depend on the installation methods used. Only small-scale, short-term and thus minor disturbances of the benthos are to be expected due to a gentle laying of the submarine cable systems and pipelines by means of flush-in methods or laying of pipelines.

In the event of a population decline due to a natural or anthropogenic disturbance (e.g. flushing of the cables), enough potential organisms remain in the overall system for recolonisation (KNUST et al. 2003). The linear character of the submarine cable systems and pipelines favours recolonisation from the undisturbed marginal areas.

Turbidity plumes are caused by the disturbance of the sediment during the flushing in of the cable system or the laying of pipelines. The dispersion of sediment particles depends to a large extent on the content of fine constituents and the hydrographic situation (especially sea state, current) (HERRMANN & KRAUSE 2000). Due to the prevailing sediment characteristics in the North Sea EEZ, most of the released sediment will settle directly at the construction site or in its immediate vicinity.

Thus, according to the current state of knowledge, the impairments during the construction phase remain small-scale and generally short-term.

Also in the short term and on a small scale, benthic organisms can be affected by the release of nutrients and pollutants associated with the resuspension of sediment particles. The oxygen content can decrease when organic substances are brought into solution (HERRMANN and KRAUSE 2000).

The impacts are generally considered to be low, as the laying of pipelines is limited in time and space and the pollutant load in the EEZ area is comparatively low. In addition, waves and currents quickly dilute any increases in the concentration of nutrients and pollutants that may occur.

Potential effects arising from any repair work that may become necessary are comparable to the possible construction-related effects.

Plant-related: In the area of overlying pipelines or possible crossings, the disturbances are permanent but also small-scale. Necessary crossings are secured with rock fill, which permanently represents an off-site hard substrate. The off-site hard substrate provides new habitat for benthic organisms.

Operational heating of the top sediment layer of the seabed directly above live cable systems can cause a reduction in the winter mortality of the infauna and lead to a change in the species communities in the area of the cable routes. In particular, cold-water-loving species (e.g. *Arctica islandica*) may be displaced from the area of the cable routes. According to the current state of knowledge, no significant impacts on the benthos due to cable-induced sediment heating are to be expected if sufficient installation depth is maintained and state-of-the-art cable configurations are used. No significant impacts on the macrozoobenthos are expected from electric and electromagnetic fields either.

With sufficient installation depth and taking into account that the effects will be small-scale, i.e. only a few metres on either side 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 small-scale and largely short-term.

For pipelines, the chemicals resulting from an impression test can be discharged into the water body in high dilution. To protect the pipeline from external corrosion, sacrificial anodes made of zinc and aluminium are attached at regular intervals, which are only dissolved in small quantities and released into the water column. Due to the very high dilution, they are only present in trace concentrations; in the water, they are adsorbed to sinking or resuspended sediment particles and sediment on the seabed.

4.3.3 Biotope types

Pipelines can have an impact on biotopes. These impacts apply equally to all designated reserved areas for pipelines.

Due to construction, possible impacts of pipelines on the protected biotope types may result from a direct claim on protected biotopes, a possible overlap due to sedimentation of released material and potential habitat changes. Direct use of protected biotopes is avoided as far as possible through the planning of the pipeline systems. Furthermore, protected biotopes according to sec. 30 BNatSchG are to be treated with special weight in the context of the concrete approval procedure and avoided as far as possible in the context of fine routing.

Impacts from overburden are expected to be small-scale due to the prevailing sediment characteristics, as the released sediment will settle quickly.

Permanent habitat changes caused by the installation are limited to the area where pipelines rest on the seabed and the immediate area of riprap, which is required in the case of crossings. The pipelines and riprap permanently constitute an off-site hard substrate, even in areas with predominantly homogeneous sandy seabed.

Known occurrences of protected biotopes according to sec. 30 BNatSchG are avoided as far as possible. Due to the lack of reliable data at the level of this SEA, it is not possible to examine whether the marine biotope types considered in sec. 30 BNatSchG para. 1 no. 6 actually occur in the area of the planned transmission lines and, if so, whether they will be impaired, as there has been no detailed biotope mapping covering the entire area of the North Sea EEZ to date.

In principle, it is assumed that the occurrence of biotopes protected according to sec. 30 BNatSchG, which are specifically sensitive to the laying of the pipeline, in particular reefs, only occur on a small scale and at certain points and can be bypassed in the course of the fine routing. If it is not possible to bypass these strictly protected biotopes or FFH-LRT, e.g. because the occurrences are more extensive, a significant impairment of these legally protected biotopes cannot be ruled out. In the specific individual procedure, it must be checked on the basis of available data from the route surveys whether the affected area is so large that there is a significant impairment.

4.3.4 Fish

The general impacts of submarine cables and pipelines on fish fauna are presented in Chapter 3.3.3 The objectives and principles for pipelines in the ROP take into account the gentlest possible laying methods, the bundling of pipelines and optimised routing. The spatial planning area designations for the pipelines are therefore not expected to have any additional or significant impacts on fish fauna.

4.3.5 Marine mammals

The maritime spatial plan makes statements regarding the reduction of the impact on the marine environment to be aimed for by taking into account the best environmental practice in accordance with the OSPAR and HELCOM Conventions as well as the respective state of the art in the laying, operation, maintenance and dismantling of submarine pipelines. This can reduce adverse impacts on the marine environment.

The designation of areas for pipelines in the maritime spatial plan means that interactions between uses and cumulative effects on biological assets can be better assessed and predicted in existing and, above all, future planning.

4.3.6 Avifauna

The general impacts of power lines on avifauna are described in Chapters 3.3.5 and 3.3.6 The effects are exclusively temporary and local.

Significant impacts of the spatial planning specifications on avifauna can be excluded with the necessary certainty.

4.3.7 Bats and bat migration

The general effects of power lines on bats are described in Chapter 3.3.7 The effects are exclusively temporary and local.

Significant impacts of the spatial planning specifications can be ruled out with the necessary certainty.

4.3.8 Cultural assets and other material assets

The specifications for the planning, construction and operation of wind turbines and power lines aim to avoid or reduce construction-related disturbances to the seabed affecting discovered and undiscovered cultural heritage by involving the specialist authorities at an early stage. Synergy effects are to be promoted through cooperation in the evaluation of subsoil investigations and soil samples, which will be carried out in the context of the large-scale development of marine areas for wind energy, and which can provide new insights into cultural traces such as submerged landscapes.

The general impacts of pipelines on cultural assets and other material assets are described in Chapter 3.3.9. Significant impacts of the spatial planning specifications can be ruled out with the necessary certainty.

4.4 Raw material extraction

As a principle of spatial planning, the areas SKN1 and SKN2 are designated as reserved areas for sand and gravel extraction, the areas KWN1 to KWN5 as reserved areas for hydrocarbons.

4.4.1 Soil

The general provisions of the ROP regarding the extraction of raw materials have a fundamentally positive impact on soil as a protected resource:

- Concerted extraction of raw material deposits with as little land use as possible,
- Reduce the impact on the environment by taking into account the best environmental practice according to the OSPAR and Helsinki Conventions when exploring for and extracting raw materials,
- Project-related monitoring to ensure environmentally compatible raw material extraction,
- Avoiding damage to sandbanks, reefs and submarine structures created by gas leaks.

Due to the spatial specifications in the ROP, the use of raw material extraction is also assigned a longer-term spatial requirement (securing land with possible use), which temporally exceeds, for example, the duration of the valid OAM III operating plan.

With regard to the definition of the reserved areas for the extraction of hydrocarbons, there are no additional impacts for the protected resource soil.

With regard to sand and gravel extraction, the reserved areas SKN1 and SKN2 are defined in the ROP, which are located within the marine protected area "Sylt Outer Reef - Eastern German Bight". As described in Chapter 3.4.1, the current extraction activities in the SKN1 reservation area (permit field OAM III) - according to monitoring data - do not cause any significant impairment of the original substrates and the legally protected biotopes "reefs" and "species-rich gravel, coarse sand and shingle beds". The seabed is therefore affected by the impacts of the current raw material extraction in the OAM III permit field, but does not undergo any significant changes. The sedimentological conditions in the reserved areas SKN1 and SKN2 are comparable, whereby the sediment distribution within SKN2 shows a smaller-scale heterogeneity.

Thus, according to the current state of knowledge - within the framework of locally adapted ancillary provisions and by means of carrying out suitable monitoring studies - no significant impairments of the soil as an object of protection are to be expected as a result of the designation of the SKN1 and SKN2 reserved areas.

4.4.2 Benthos and biotope types

The general impacts of raw material use are described in Chapter 3.4.2 With regard to the designation of areas KWN1 to KWN5 for the extraction of hydrocarbons, there are no additional impacts.

With regard to the designation of areas SKN1 and SKN2 as reserved areas for sand and gravel extraction, their location within the nature conservation area "Sylt Outer Reef - Eastern German Bight" must be taken into account.

On the basis of the monitoring carried out to date (see Chapter 3.4.2) and in compliance with the incidental provision of the main operating plan, it can be assumed that significant impairments to benthic habitats and their communities can be ruled out with the necessary degree of certainty through the designation of areas SKN1 and SKN2.

4.4.3 Fish

The general effects of raw material extraction on fish fauna can be found in Chapter 3.4.3

The exact formulation of the spatial planning specifications for raw material extraction takes place in the mining law procedure. The designations are redrawings of already approved or existing activities.

Due to overlaps of the raw material extraction areas with the staging, wintering and spawning areas of sand eels, significant negative effects on this key species cannot be excluded (see Chapter 3.4.3). Scientific findings on the population size of sand eels in the extraction area, which could be used for a significance assessment, are lacking (IFAÖ 2019a). These impacts are currently present even if the plan is not implemented, so that significant adverse effects on fish fauna as a result of the ROP's zoning can be ruled out with the necessary degree of certainty.

According to current knowledge, the spatial designations for the extraction of hydrocarbons will not lead to any additional or significant impacts on fish fauna.

4.4.4 Marine mammals

The basis for the designations excluding the reserved areas KWN2 and KWN3 and the priority area KWN1 for hydrocarbon extraction in zones 4 and 5 are the corresponding permits pursuant to Section 7 BBergG and licences pursuant to Section 8 BbergG (cf. Chapter 3.4, Designations for raw material extraction in the ROP 2021). The specifications are therefore subsequent drawings of already approved or existing activities. The incorporation of the raw material extraction areas into the maritime spatial plan means that the interactions between the uses and cumulative effects on biological assets can be better assessed and forecast for existing and, above all, future planning.

On the basis of the above statements and the illustrations in Chapter 3.4.4SEA concludes that no significant impacts on marine mammals are to be expected, but rather that adverse impacts will be avoided compared to not implementing the plan.

4.4.5 Seabirds and resting birds

The basis for the designation of the reserved areas KWN1 to KWN5 for hydrocarbon extraction are the permit fields NE3-0002-01, NE3-0001-01 and B 20 008/71 in accordance with Section 7 of the Federal Mining Act (BbergG) and the German North Sea permit A6/B4 in accordance with Section 8 of the Federal Mining Act (BBergG) (cf. Chapter 3.4, Designations for raw material extraction in the ROP 2021). The specifications are based on already approved or existing activities. The spatial planning specifications are therefore not expected to increase the intensity of use in the areas. Significant impacts of the specifications can be ruled out with the necessary certainty.

The reserved areas SKN1 and SKN2 for sand and gravel extraction are located (with the exception of part of the reserved area SKN2) within the nature conservation area "Sylt Outer Reef - Eastern German Bight". The reserved area SKN1 lies entirely within sub-area II of the nature conservation area and thus within the bird sanctuary "Eastern German Bight". Both reserved areas also lie entirely within the main concentration area of divers in spring.

In the status description and assessment of nature conservation areas in the North Sea EEZ, the impacts of sand and gravel extraction in permit field OAM III (SKN1) on the seabird species or species groups protected in the bird sanctuary were predominantly assessed as "negligible" (BfN 2017). For divers and alcids, only minor impacts resulted from the low extraction of sand and gravel in previous years. This also corresponds to a current expert assessment as part of the FFH compatibility study of the OAM III permit field (IFAÖ 2019). Furthermore, there are no findings on fundamental changes in the sediment structure due to the extraction of sand and gravel and thus potential changes in the feeding grounds of seabirds (IFAÖ 2019). Other impacts from sand and gravel extraction are mainly temporary and local (see Chapter 3.4.5). In addition, the maritime spatial plan contains the principle (cf. Principle (2) under Extraction of raw materials) that sand and gravel extraction in the reserved area for divers should be avoided as far as possible in the period from 1 March to 15 May.

Significant impacts of the determinations can be excluded with the necessary certainty.

4.4.6 Migratory birds

Significant impacts of the spatial planning designations of reserved areas for sand and gravel extraction and the extraction of hydrocarbons as well as the priority area for the extraction of hydrocarbons can be excluded with the necessary certainty.

4.4.7 Cultural assets and other material assets

The general impacts of the spatial planning specifications for sand and gravel extraction and the extraction of hydrocarbons on cultural assets and other material assets are described in Chapter 3.4.8. Significant impacts of the spatial planning specifications can be excluded with the necessary certainty, taking into account Principle 3 on general requirements for economic uses.

4.5 Fisheries and aquaculture

The ROP contains a general definition for aquaculture.

The general impacts of aquaculture on the various protected goods are described in Chapter 3.5

Since the aquaculture designation is not a spatial but only a general designation, both the future location and the concrete design of the use are currently unknown. In order to be able to exclude a significant impact on the marine environment, the following requirements must be met and their fulfilment must be examined in downstream plans or at project level:

- Inputs of nutrients and excreta limited to a tolerable level
- No entries of medicines/antibiotics
- Aquaculture limited to native species
- No use of organisms from wild stocks
- Avoidance of negative impacts on wildlife populations
- Any deterrence measures limited to a tolerable level.

The ROP contains a designation for fisheries on Norway lobster in the form of the reserved area FiN1. The assessment of the possible impacts of the fisheries designation is presented in the following chapters in relation to specific protected species.

4.5.1 Floor

The impairment of the seabed with regard to fishing use is presented in Chapter 3.5.1As the planned reserved area for Nephrops fishery (FiN1) has been considered a traditional main area for Nephrops for decades, no further significant impacts on the protected property "soil" are to be expected with regard to this ROP designation.

In order to exclude a significant impact of aquaculture on the soil as a protected resource, the input of nutrients and excreta should be kept to a minimum. The input of medicines, especially antibiotics, should be avoided.

4.5.2 Benthos and biotope types

With regard to the use of fisheries, there are no further specific effects of the ROP provisions compared to the general effects of use described in Chapter 3.5.2

Increases in fishing effort due to the designation as a reserved area are not predicted. Thus, significant impacts on benthic communities and biotopes can be ruled out due to the fisheries provisions of the ROP.

4.5.3 Fish

The intensity and general effects of fishing on fish fauna are described in Chapters 2.7.3and 3.5.3

The designated reserved area for Norway lobster fishing does not change the intensity of fishing in the area. The spatial planning specifications for fisheries therefore do not result in any additional significant impacts on fish fauna.

4.5.4 Marine mammals

Implementation of the Plan will not result in any impacts on marine mammals other than those already described in Section 3.5.4 The designation of the reserved area FinN for Nephrops fisheries does not lead to an increase in current fishing activity in this area of the EEZ.

4.5.5 Avifauna

With regard to the use of fisheries, there are no further effects of the ROP designations compared to the general effects of use described in Chapters 3.5.5and 3.5.6 No increase in fishing activity in this area is expected as a result of the designation of the FiN1 reserved area for nephrops fishing.

4.5.6 Cultural assets and other material assets

The general impacts of the spatial planning specifications for fisheries on cultural assets and other material assets are described in Chapter 3.5.7. Significant impacts of the spatial planning specifications can be excluded with the necessary certainty, taking into account Principle 3 on general requirements for economic uses.

4.6 Marine research

For marine research, in particular the fisheries research activities of the Thünen Institute, the GSBTS boxes of the Thünen Institute of Sea Fisheries are designated as reserved research areas FoN1 to FoN3 in the North Sea.

The designation is made to safeguard existing long-term research series in the field of fisheries research. The aim is to keep these areas free from uses that could devalue the long-term research series.

The results of marine science research should be continuously recorded to explain ecosystem interrelationships as comprehensively as possible and thus create an important basis for sustainable development of the EEZ.

As this is a question of safeguarding the existing situation, the area specifications have no further effects on the protected goods and the marine environment as a whole compared to the current situation and the zero variant.

4.6.1 Floor

The ROP specifications do not result in any further specific impacts on the seabed than those described in Chapter 3.6.1 Significant impacts on the soil as a protected resource as a result of the ROP specifications for marine research use can therefore be ruled out.

4.6.2 Benthos and biotope types

With regard to the use of marine research, there are no further specific effects of the ROP's specifications compared to the general effects of use described in Chapter 3.6.2 Significant impacts on benthic communities and biotopes due to the ROP provisions on marine research can therefore be ruled out.

4.6.3 Fish

Compared to the impacts on fish fauna described in Chapter 3.6.3spatial planning stipulations of the research are not expected to result in any additional or significant changes.

4.6.4 Marine mammals

The designation of reserved areas for scientific research means that interactions between uses and cumulative effects on biological assets can be better assessed in existing and, above all, future planning.

On the basis of the above statements and the illustrations in Chapter 3.6.4concluded for the SEA that no significant impacts on marine mammals are to be expected as a result of the designations for scientific research in the maritime spatial plan, but rather that adverse impacts are avoided in comparison with the non-implementation of the plan.

4.6.5 Avifauna

With regard to marine research, there are no further specific effects of the ROP's provisions compared to the general effects of use described in Chapter 3.6.5 Significant impacts on seabirds, resting birds and migratory birds due to the ROP's provisions on marine research can be ruled out with the necessary certainty.

4.6.6 Cultural assets and other material assets

The general impacts of the spatial planning specifications for marine research on cultural and other material assets are described in Chapter 3.6.7. Significant impacts of the spatial planning specifications can be ruled out with the necessary certainty, taking into account Principle 2 on scientific uses.

4.7 Protection and enhancement of the marine environment

The national marine protected areas Borkum Riffgrund, Doggerbank, Sylt Outer Reef - Eastern German Bight in the EEZ of the North Sea are designated as priority areas for nature conservation in accordance with their conservation purposes.

The "main concentration area of divers" defined in the BMU position paper of 2009 is identified as a diver priority area.

The main summer distribution area of harbour porpoises (according to the BMU's noise protection concept of 2013) is designated as a temporary reserved area "Harbour porpoises (May to August)".

The temporary exclusion of installations excludes the construction of installations above the water surface on this area.

The goal of climate neutrality in Germany, which has been brought forward to 2045, will require further expansion of renewable energies. For this reason, further areas are also needed in the EEZ for use by offshore wind energy. The German government will therefore commission studies to examine the compatibility of wind power use on the Dogger Bank with nature conservation objectives.

The designations help to ensure that the marine environment in the EEZ is permanently preserved and developed as an ecologically intact open space over a large area. The designation of areas that have an important species-specific ecological function - the main concentration area of divers and the main distribution area of harbour porpoises - as reserved areas serves to provide special protection for the species group of divers and harbour porpoises that is sensitive to disturbance. The maritime spatial plan thus contributes to achieving the objectives of the MSFD.

4.7.1 Soil

The maritime spatial plan reinforces nature conservation in the German EEZ by designating priority areas for nature conservation. This supports the expected positive effects of management measures for marine protected areas on soil as a protected resource.

4.7.2 Benthos and biotope types

The designation of the designated nature conservation areas of the North Sea EEZ as priority areas for nature conservation supports the positive effects on benthic communities and biotopes that can be expected on the basis of appropriate management measures of the nature conservation areas.

The spatial planning designation as a priority area supports the maintenance or restoration of a favourable conservation status for the habitat types that characterise the nature conservation areas according to Annex I of Directive 92/43/EEC (sandbanks with only slight permanent overtopping by seawater (EU code 1110) and reefs (EU code 1170), as well as a natural or near-natural development of species-rich gravel, coarse sand and shingle beds and the function of these habitats as a regeneration area for benthic communities.

4.7.3 Fish

The general impact of nature reserves on the fish community is described in chapter 3.7.3

The designation of nature conservation areas as priority areas in the EEZ could have a positive impact on fish fauna. In particular, marine protected areas could increase the species diversity and condition of the fish fauna and counteract the overexploitation of fish stocks.

4.7.4 Marine mammals

The harbour porpoise is one of the protected species in all three nature conservation priority areas. In addition, the plan designates the main concentration area identified in the BMU noise protection concept (2013) as a priority area for harbour porpoises during the sensitive period from 1 May to 31 August inclusive. The designation of priority areas for wind energy exclusively outside priority areas for nature conservation leads to the avoidance and mitigation of negative impacts on harbour porpoise populations in the German EEZ of the North Sea. The designation of the harbour porpoise priority area additionally protects important habitats during the breeding season.

As a result, the nature conservation specifications have a positive impact on the conservation status of the harbour porpoise population.

4.7.5 Avifauna

Among other things, the maritime spatial plan designates the nature reserve "Sylt Outer Reef - Eastern German Bight" with the bird sanctuary in sub-area II of the complex area as a priority area for nature conservation. This provides special protection for the habitat of specially protected species and regularly occurring migratory bird species. By designating priority and reserved areas for wind energy exclusively outside priority areas for nature conservation, the impacts of offshore wind energy on protected and other bird species and their habitat, such as habitat loss and collision risks, are reduced.

The main concentration area of common divers is also designated as a priority area for common divers (cf. ROP Principle (1) Chap. 2.4 Nature conservation). The designation of the main diver concentration area, which is larger in terms of area, as a priority area encompassing sub-area II of the nature conservation area "Sylt Outer Reef - Eastern German Bight" may also have a positive impact on other species protected in the nature conservation area or bird sanctuary and their feeding and resting grounds. In addition, military use should have as little impact as possible on the conservation purpose of the priority area for divers. For the period from 1 March to 15 May of any given year, the diver priority area is not to be affected by sand and gravel extraction, and the Federal Armed Forces authorities and the competent nature conservation authority are to reach agreement on military use (cf. ROP Principle (2) Chap. 2.4 Nature conservation). This takes additional account of the protection of the diver species group, which is sensitive to disturbance, and its particularly important habitat in the North Sea EEZ. The designation of the reserved areas for common divers (StN1 to StN3) also takes account of the sustainable use of the reserved areas EN4 and EN5.

In addition, the exclusion of turbines above the water surface from the definition 2.4 (4) serves to ensure the implementation of measures to safeguard the coherence of the Natura 2000 network (coherence measures) with regard to impairments caused by existing wind turbines in the priority or reserved area for divers. In order to enable nature conservation planning to develop its own compensation scheme in this respect, the temporary designation 2.4 (4) is made as spatial planning support, which temporarily protects the area in question from conflicting uses. This also supports the protection of divers.

Overall, the spatial planning provisions on nature conservation in the EEZ have exclusively positive effects on seabird and resting bird species as well as migratory birds.

4.8 National and alliance defence

In the EEZ of the North Sea, the reservation areas for national and alliance defence are defined.

The reserved areas are used for training, exercise and testing activities of the navy and air force of the Bundeswehr and alliance partners.

With regard to national and alliance defence, there are no further specific effects of the ROP's specifications compared to the general effects of use on the various protected goods described in Chapter 3. Significant impacts due to the ROP's provisions on national and alliance defence can therefore be ruled out.

4.9 Other uses without spatial specifications

4.9.1 Air traffic

Air traffic over the EEZ takes place in the context of commercial flights at higher altitudes. No direct impact on the marine environment is to be expected from the provisions of the ROP.

4.9.2 Leisure

Recreational activities in the EEZ are mainly carried out by traffic with private smaller motor and sailing boats. In contrast to areas closer to the coast, relatively low frequencies and environmental impacts are assumed. No direct impact on the marine environment is expected as a result of the provisions of the ROP.

4.10 Interactions

In general, impacts on a protected good lead to various consequential effects and interactions between the protected goods. For example, impacts on the soil or the water body usually also have consequential effects on the biotic protected goods in these habitats. For example, pollutant leaks can reduce water and/or sediment quality and be taken up by benthic and pelagic organisms from the surrounding medium. The essential interconnection of the biotic protected goods exists via the food chains. These interrelationships between the different protected goods and possible impacts on biodiversity are described in detail for the respective protected goods.

Sediment rearrangement and turbidity plumes

During the construction phase of wind farms and platforms or the laying of a submarine cable system, sediment redistribution and turbidity plumes occur. Fish are temporarily scared away. The macrozoobenthos is locally covered. Thus, the feeding conditions for benthic fish and for fish-eating seabirds and harbour porpoises also change for a short time and locally (decrease in the supply of available food). However, due to the mobility of the species and the temporal and spatial limitation of sediment redistribution and turbidity plumes, significant impacts on the biotic protected goods and thus on the existing interactions between them can be excluded with the necessary certainty.

Noise emissions

The installation of turbines can lead to temporary flight reactions and temporary avoidance of the area by marine mammals, some fish species and seabird species. Large gulls, on the other hand, are attracted to the construction activities. Avoidance by seabirds sensitive to disturbance, on the other hand, would reduce the risk of bird strikes.

Land use

The installation of foundations will result in a local loss of settlement area for the benthic ecosystem, which can potentially lead to a deterioration of the food base for the fish, birds and marine mammals that follow within the food pyramid. However, benthic seabirds in deeper water areas are not affected by the loss of foraging areas due to the sealing of the area, as the water is too deep for effective foraging.

Placement of artificial hard substrate

The introduction of artificial or off-site hard substrate (e.g. foundations, cable crossing structures) leads locally to a change in soil composition and sediment conditions. As a result, the composition of the macrozoobenthos may change. According to KNUST et al. (2003), the introduction of artificial hard substrate into sandy soils leads to a settlement of additional species. The recruitment of these species will most likely come from the natural hard substrate habitats, such as superficial boulder clay and stones.

Thus, the risk of a negative impact on the benthic sand-bottom communities by species untypical of the area is low. However, settlement areas of the sandy bottom fauna are lost at these sites. By changing the species composition of the macrozoobenthic community, the food basis of the fish community at the site can be influenced (bottom-up regulation).

Certain fish species could be attracted, which in turn increase the feeding pressure on the benthos through predation and thus shape the dominance ratios through selection of certain species (top-down regulation).

Prohibition of use and driving

Within and around the wind farms and platforms, fishing is prohibited. The restriction of fishing can lead to an increase in the population of both fishery target species and non-utilised fish species; a shift in the length spectrum of these fish species is also conceivable. In the case of an increase in fish stocks, an enrichment of the food supply for marine mammals is to be expected. Furthermore, it is expected that a macrozoobenthic community undisturbed by fishing activity will develop. This could mean that the diversity of the species community will increase, with sensitive and long-lived species of the current epi- and infauna having a better chance of survival and developing stable populations.

Due to the variability of the habitat, interactions can only be described very imprecisely. In principle, it can be stated that no effects on existing interactions that could result in a threat to the marine environment are currently discernible as a result of the implementation of the ROP. Therefore, it must be concluded for the SEA that, based on the current state of knowledge, no significant effects from interactions on the living marine environment are to be expected as a result of the specifications in the maritime spatial plan, but rather that adverse effects can be avoided in comparison with non-implementation of the plan.

4.11 Cumulative effects

4.11.1 Soil, benthos and biotope types

A significant part of the environmental impacts of the areas for offshore wind energy and reserved areas for transmission lines on soil, benthos and biotopes will occur exclusively during the construction period (formation of turbidity plumes, sediment relocation, etc.) and in a spatially limited area. Due to the gradual implementation of the construction projects, construction-related cumulative environmental impacts are unlikely. Possible cumulative impacts on the seabed, which could also have a direct impact on the benthos and specially protected biotopes, result from the permanent direct land use for the foundations of the facilities and the installed pipelines. The individual impacts are generally small-scale and local.

In the area where pipelines are laid, the impairment of 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 shingle beds, permanent impairment would have to be assumed.

With regard to a balance of land use, reference is made to the environmental report on the FEP 2019 or FEP draft 2020. There, the direct land use by wind energy and power cables is estimated on the basis of model assumptions.

Due to the lack of a reliable scientific basis, no statement can be made on the use of specially protected biotopes according to sec. 30 BNatSchG. An area-wide sediment and biotope mapping of the EEZ, which is currently being carried out, will provide a more reliable assessment basis in the future.

In addition to the direct use of the seabed and thus the habitat of the organisms settled there, plant foundations, overlying pipelines and necessary crossing structures lead to an additional supply of hard substrate. This can lead to the settlement of non-native hard substrate-loving species and change the species composition. This effect can lead to cumulative effects through the construction of several offshore structures, pipelines or riprap in crossing areas of pipelines. The hard substrate introduced also results in a loss of habitat for benthic fauna adapted to soft bottoms. However, as the land use for both the grid infrastructure and the wind farms will be within the ‰ range, no significant impacts are to be expected, even in the cumulative effect, which would lead to a threat to the marine environment in relation to the seabed and the benthos.

4.11.2 Fish

The impacts on fish fauna due to the designations are probably most strongly determined by the realisation of initially 20 GW of wind energy in the reserved areas of the North Sea and Baltic Sea. Here, the impacts of the OWPs are concentrated on the one hand on the regularly ordered closure of the area to fishing, and on the other hand on the change in habitat and its interaction.

The anticipated fishery-free zones within the wind farm areas could have a positive impact on the fish fauna by eliminating negative fishing effects, such as disturbance or destruction of the seabed and catch and bycatch of many species. Due to the lack of fishing pressure, the age structure of the fish fauna could return to a more natural distribution, so that the number of older individuals increases. The OWP could develop into an aggregation site for fish, although it has not yet been conclusively clarified whether wind farms attract fish.

In addition to the absence of fisheries, an improved food base for fish species with a wide variety of diets would also be conceivable. The vegetation of the wind turbines with sessile invertebrates could favour benthophagous species and make a larger and more diverse food source accessible to the fish (LINDEBOOM et al. 2011). This could improve the condition of the fish, which in turn would have a positive effect on fitness. Currently, research is needed to translate such cumulative effects to the population level of fish.

Furthermore, the wind farms of the southern North Sea could have an additive effect beyond their immediate location, in that the mass and measurable production of plankton could be dispersed by currents, affecting the qualitative and quantitative composition of zooplankton (FLOETER et al. 2017). This in turn could affect planktivorous fish, including pelagic schooling fish such as herring and sprat, which are the target of one of the largest fisheries in the North

Sea. Species composition could also change directly, with species with different habitat preferences than established species, such as reef dwellers, finding more favourable living conditions and becoming more abundant. At the Danish wind farm Horns Rev, a horizontal gradient in the occurrence of hard-substrate species was observed between the surrounding sandy areas and near the turbine foundations 7 years after construction: Cliff perch Ctenolabrus rupestris, eelpout Zoarces viviparous and lumpfish Cyclopterus lumpus were significantly more abundant near the wind turbine foundations than on the surrounding sand flats (LEONHARD et al. 2011). Cumulative effects resulting from extensive offshore wind energy development could include

- an increase in the number of older individuals,
- better conditions for the fish due to a larger and more diverse food base,
- Further establishment and distribution of fish species adapted to reef structures,
- the recolonisation of previously heavily fished areas and surfaces,
- better living conditions for territorial species such as cod-like fish.

In addition to predation, the natural mechanism for limiting populations is intra- and interspecific competition, which is also called density limitation. It cannot be ruled out that within individual wind farms local density limitation sets in before the favourable effects of the wind farms propagate spatially, 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 might have on other elements of the food web, both below and above their trophic level, cannot be predicted at the current state of knowledge.

Together with the designation of nature conservation areas, wind farm areas could contribute to positive stock developments and thus to the recovery of fish stocks in the North Sea.

4.11.3 Marine mammals

Cumulative impacts on marine mammals, in particular harbour porpoises, may occur primarily due to noise exposure during the installation of deep foundations. Thus, marine mammals can be significantly affected by the fact that - if pile driving is carried out simultaneously at different locations within the EEZ - not enough equivalent habitat is available to avoid and retreat to.

The realisation of offshore wind farms and platforms to date has been relatively slow and gradual. From 2009 to 2018, pile driving was carried out at twenty wind farms and eight converter platforms in the German EEZ of the North Sea. Since 2011, all pile driving has been carried out using technical noise mitigation measures. Since 2014, the noise protection values have been reliably complied with and even undercut thanks to the successful use of noise reduction systems. The majority of the construction sites were located at distances of 40 to 50 km from each other, so that there was no overlapping of noise-intensive pile driving work that could have led to cumulative effects. Only in the case of the two directly adjacent projects Meerwind Süd/Ost and Nordsee Ost in Area 4 was it necessary to coordinate the pile-driving work, including the measures to confine the birds.

The evaluation of the sound results with regard to sound propagation and the possibly resulting accumulation has shown that the propagation of impulsive sound is strongly restricted when effective sound minimising measures are applied (BRANDT et al. 2018, DÄHNE et al., 2017).

Cumulative effects of the plan on the harbour porpoise population are considered in accordance with the requirements of the BMU noise protection concept of 2013. In order to avoid and reduce cumulative impacts on harbour porpoise populations in the German EEZ, a restriction of sound emissions from habitats to maximum permitted areas of the EEZ and nature conservation areas is specified in the downstream approval procedure. Accordingly, the propagation of sound emissions may not exceed defined areas of the German EEZ and nature conservation areas. This ensures that sufficient high-quality habitats are available to animals for escape at all times. The order primarily serves to protect marine habitats by avoiding and minimising disturbances caused by impulsive sound emissions.

Specifically, the order provides for the following in the downstream approval notices:

- It shall be ensured with the necessary certainty that at any time no more than 10% of the area of the German EEZ of the North Sea and no more than 10% of a neighbouring nature conservation area is affected by noise-inducing pile driving activities.
- During the porpoise's sensitive period from 1 May to 31 August, it shall be ensured with the necessary certainty that no more than 1% of sub-area I of the nature conservation area "Sylt Outer Reef - Eastern German Bight" with its special function as a nursery area is affected by sound-intensive pile-driving work for the foundation of the piles from disturbance-triggering sound inputs.

By designating the area of conservation concern for harbour porpoises, the standards for the protection of impulsive noise emissions that apply to projects in and around the nature conservation area "Sylt Outer Reef - Eastern German Bight" will in future also apply to projects in and around the area of conservation concern in the context of downstream approval procedures.

The harbour porpoise reserve in the summer months comprises the protected area "Sylt Outer Reef" and its immediate surroundings. Pile driving activities that have the potential to cause disturbance due to noise in the main concentration area of the harbour porpoise during the sensitive season are coordinated in such a way that the proportion of the area affected always remains below 1%. In accordance with the BMU's noise protection concept (2013), all pile-driving activities are coordinated with the aim of ensuring that there are always sufficient alternative sites in the protected areas, in equivalent habitats and in the entire German EEZ.

In conclusion, the implementation of the plan will lead to avoidance and mitigation of cumulative impacts. This assessment also applies with regard to cumulative impacts of the various uses on marine mammals.

4.11.4 Seabirds and resting birds

The uses considered in the maritime spatial plan can have different effects on seabirds and resting birds, in particular from the use of offshore wind energy through the vertical structures such as platforms or offshore wind turbines, such as habitat loss, an increased collision risk or a scaring and disturbing effect. These effects are considered on a site- and project-specific basis as part of the environmental impact assessment and monitored as part of the subsequent monitoring of the construction and operation phases of offshore wind farm projects. For seabirds and resting birds, habitat loss due to cumulative impacts of several structures or offshore wind farms can be particularly significant. The cumulative impacts of offshore wind energy on seabirds and resting birds are therefore discussed below.

In order to assess the significance of cumulative effects on seabirds and resting birds, any impacts must be assessed on a species-specific basis. In particular, species of Annex I of the V-Directive, species of sub-area II of the nature reserve "Sylt Outer Reef - Eastern German Bight" and such species for which an avoidance behaviour towards structures has already been determined have to be considered with regard to cumulative effects.

When assessing the cumulative effects of offshore wind farms, special attention must be paid to the group of divers, including the endangered and sensitive species of red-throated and black-throated divers. GARTHE & HÜPPOP (2004) attest divers a very high sensitivity to structures. For the consideration of cumulative effects, neighbouring wind farms as well as those located in the same contiguous functional spatial unit defined by physically and biologically significant properties for a species have to be taken into account. Furthermore, in addition to the structures themselves, impacts from vessel traffic (including for the operation and maintenance of cables and platforms) must also be included. Current findings from studies confirm the scaring effect on divers triggered by ships. Red-throated and black-throated divers are among the most sensitive bird species in the German North Sea to ship traffic (MENDEL et al. 2019, FLIESSBACH et al. 2019, BURGER et al. 2019).

The main concentration area takes into account the most important period for the species, the spring. Based on the data available at the time the main concentration area was defined in 2009, the main concentration area accommodates approx. 66% of the diver population in the German North Sea and approx. 83% of the EEZ population in spring and is therefore particularly important from a population biology point of view (BMU 2009) and an important functional component of the marine environment with regard to seabirds and resting birds. Against the background of current population calculations, 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).

Current results from operational monitoring of offshore wind farms and from research projects, some of which used study methods independent of the standardised monitoring according to the standard study concept (StUK) (e.g. telemetry study within the framework of the DIVER project), consistently show that the avoidance behaviour of divers towards offshore wind farms is far more pronounced than had been anticipated in the original approval decisions of the wind farm projects (cf. Chapter 3.2.5).

Interim results of a study by the FTZ were presented at the BSH's Marine Environmental Symposium 2018. The evaluations have been published (GARTHE et al. 2018, SCHWEMMER et al. 2019). The cumulative consideration of the avoidance behaviour of divers towards offshore wind farms resulted in a calculated complete habitat loss of 5.5 km and a statistically significant decrease in abundance up to a distance of 10 km, starting from the periphery of a wind farm (GARTHE et al. 2018). For the statistically significant decrease in abundance, this is not a total avoidance, but a partial avoidance with increasing diver densities up to a distance of 10 km from a wind farm. The calculated complete habitat loss of 5.5 km is used to quantify the habitat loss in analogy to the former shy distance of 2 km. It is subject to the purely statistical assumption that no divers occur up to a distance of 5.5 km from an offshore wind farm. Another cross-project study on the occurrence and distribution of divers and the effects of offshore wind farm projects on divers in the German North Sea, commissioned by the BWO, provided comparable results with a significant avoidance distance of 10 km and a calculated complete habitat loss of approx. 5 km across all realised wind farm projects. The results from GARTHE et al. (2018) regarding the avoidance behaviour of divers are thus confirmed by an independent study (BIOCONSULT SH et al. 2020).

In summary, the results from monitoring as well as from research projects consistently show that the avoidance behaviour of common divers towards offshore wind farms is far more pronounced than previously assumed. A population calculation for the main concentration area as part of the FTZ diver study commissioned by BfN and BSH showed an increase in the common diver population for the period 2002 to 2012, which has remained at a relatively constant high level since 2012. However, for the entire German North Sea, whose sub-areas have locally varying importance as habitat for divers, a decrease in the common diver population has been observed since 2012 (observation period until 2017) (SCHWEMMER et al. 2019). The study commissioned by the BWO yields qualitatively and quantitatively comparable population figures and population trends for the main concentration area and the German North Sea. Differences can be attributed to different stock calculation methodologies and modified data bases.

Both studies confirm the overall high and special functional importance of the main concentration area as habitat for divers in the German North Sea (SCHWEMMER et al. 2019, BIOCONSULT SH et al. 2020). This applies in particular against the background of the pronounced avoidance behaviour and associated habitat loss.

The main concentration area represents a particularly important component of the marine environment with regard to seabirds and resting birds, especially with regard to the diver species group. The spatial planning designation of the main concentration area for divers as a priority area takes particular account of the protection of divers in this particularly important habitat, especially against the background of the observed avoidance behaviour from the operational phase of the OWPs in the North Sea EEZ. The designation of areas EN4 and EN5 within the main concentration area as reserved areas for offshore wind energy takes up the review of areas N-4 and N-5 for subsequent use in the FEP 2019 (BSH 2019) and FEP 2020 (BSH 2020a) at spatial planning level. In addition, military use should have as little impact as possible on the conservation purpose of the priority area for divers. For the period from 1 March to 15 May of a given year, no encroachment by sand and gravel extraction should occur in the priority area for divers, and the Federal Armed Forces authorities and the competent nature conservation authority should reach agreement on military use (cf. ROP Principle (2) Chap. 2.4 Nature conservation). This takes additional account of the protection of the diver species group, which is sensitive to disturbance, and its particularly important habitat in the North Sea EEZ. The designation of the reserved areas for common divers (StN1 to StN3) also takes account of the sustainable use of the reserved areas EN4 and EN5.

However, according to the current state of knowledge, it must be assumed that the wind farm projects to be realised on EN13 will have a shying effect on the priority area divers to the extent identified and that it must therefore be examined in the individual procedure to what extent avoidance and mitigation measures must be used for the specific turbines applied for.

The designations of other uses are located outside the main diver concentration area in areas that are of lesser importance for divers and/or refer to uses whose effects are mostly temporary and local (cf. corresponding subchapters in Chapters 3 and 4).

For other species of seabirds and resting birds, it can be assumed that the specifications and principles relating to divers and the main concentration area will also have a positive effect. The priority areas for nature conservation contribute to the protection of open spaces, as they exclude uses that are incompatible with nature conservation. These designations protect important habitats and reduce habitat impairments and collision risks there. Outside the nature conservation areas, some species occur over large areas within the EEZ without clear distribution centres (see Chapter 2.9.2). Moreover, the impacts of some uses are often local and limited to the duration of the use (cf. corresponding subchapters in Chapters 3and 4). In addition, some spatial planning regulations, e.g. on shipping, are not expected to lead to an increase in density or intensity of use, but rather to replications of existing levels of activity.

As a result of the SEA, significant cumulative impacts of the spatial planning specifications on the protected species of seabirds and resting birds are not to be expected according to the current state of knowledge. For the specifications for the expanded priority area EN13 and the conditional priority area EN13-North in relation to the main concentration area, this assessment can only be made taking into account the overall plan assessment of the ROP (cf. Chapter 7).

4.11.5 Migratory birds

The uses taken into account in the spatial plan can have different effects on migratory birds, such as barrier effects and collision risk, in particular from the use of offshore wind energy due to the vertical structures of the offshore wind turbines. These effects are considered on a site-specific basis as part of the environmental impact assessment and monitored as part of the subsequent monitoring of the construction and operation phases of offshore wind farm projects.

The designation of priority and reserved areas for offshore wind energy in a spatial context to each other and the safeguarding of open space in nature conservation areas reduce barrier effects and collision risks in important feeding and resting habitats. The effects of the other uses and their specifications are comparatively less extensive in terms of verticality in the airspace.

According to the current state of knowledge, significant cumulative impacts of the spatial planning specifications of all considered uses on migratory birds can be excluded with the necessary certainty.

4.12 Cross-border effects

The SEA concludes that, as things stand at present, no significant impacts on the areas of neighbouring states adjacent to the German EEZ in the North Sea are discernible as a result of the stipulations made in the ROP.

For the protected goods soil, water, plankton, benthos, biotope types, landscape, cultural heritage and other material goods and the protected good human beings and human health, significant transboundary impacts can generally be excluded. Possible significant transboundary impacts could only result from a cumulative consideration including all planned wind farm projects in the area of the German North Sea for the highly mobile protected goods, marine mammals, seabirds and resting birds as well as migratory birds and bats, if no avoidance and mitigation measures were ordered within the framework of downstream approval procedures.

For fish, the SEA concludes that, according to current knowledge, no significant transboundary impacts are to be expected from the implementation of the ROP, since on the one hand, the areas for which the ROP specifies no prominent function for 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 avoidance and mitigation measures, significant transboundary impacts on marine mammals can also be ruled out. For example, the installation of wind turbine foundations and converter platforms will only be permitted in the specific approval procedure if effective noise abatement measures are applied. For the protected species of seabirds and resting birds, the Danish bird sanctuary "Sydlige Nordsø", which directly adjoins the German EEZ to the north and also has a high occurrence of divers, must be taken into account when considering possible significant transboundary impacts. According to the information available to date, the maritime spatial plan is not expected to have any significant impacts.

For migratory birds, erected wind turbines in particular can represent a barrier or collision risk. By designating areas for wind energy exclusively outside marine nature conservation areas, these impacts are reduced in important resting areas for some migratory bird species. The other uses considered in the maritime spatial plan do not have comparable spatial impacts. According to the current state of knowledge, no significant transboundary impacts on migratory birds are to be expected from the specifications in the maritime spatial plan.

5 Species protection law assessment

5.1 General part

In the Plan area, the German EEZ in the North Sea, various European wild bird species as defined in Art. 1 of the Birds Directive as well as marine mammal species of Annexes II and IV of the Habitats Directive occur, as explained.

The present species protection assessment examines whether the plan meets the requirements of sec. 44 para. 1 no. 1 and no. 2 BNatSchG for specially and strictly protected animal species. In particular, it is examined whether the plan violates species protection prohibitions.

According to sec. 44 para. 1 no. 1 BNatSchG, killing or injuring wild animals of specially protected species, i.e. animals listed in Annex IV of the Habitats Directive and Annex I of the V Directive, is prohibited. The species protection assessment pursuant to Article 44(1)(1) of the Federal Nature Conservation Act always refers to the killing and injury of individuals.

Pursuant to sec. 44 para. 1 no. 2 BNatSchG, it is also prohibited to significantly disturb wild animals of strictly protected species during the breeding, rearing, moulting, hibernation and migration periods, whereby significant disturbance exists if the disturbance worsens the conservation status of the local population of a species.

In this respect, it is neither important whether a relevant damage or disturbance is based on reasonable grounds, nor do motives, motives or subjective tendencies play a role for the fulfilment of the prohibition elements. (Landmann/Rohmer Umweltrecht Band I - Kommentar zum BNatSchG, 2018, S. § 44 Rn. 6).

According to the legal definition of § 44 para. 1 no. 2 2nd half-sentence BNatSchG, a significant disturbance exists if the conservation status of the local population of a species is worsened. According to the Guidelines on the Strict System of Protection for Species of Community Interest under the Habitats Directive (para. 39), disturbance within the meaning of Art. 12 of the Habitats Directive occurs if the act in question reduces the chances of survival, reproductive success or reproductive capacity of a protected species, or if this act leads to a reduction in its range. On the other hand, occasional disturbances with no foreseeable negative effects on the species concerned are not to be regarded as disturbance within the meaning of Art. 12 Habitats Directive.

Among the uses defined in the plan, wind energy production is the most intensive use. In recent years, the use of avoidance and mitigation measures and their monitoring has increased the level of knowledge in connection with impacts relevant to species protection.

In the following, species protection concerns are examined with regard to wind energy production. Subsequently, possible cumulative impacts with other uses are presented.

5.2 Marine mammals

In the German North Sea EEZ, the harbour porpoise, the common seal and the grey seal are species listed in Annex II (animal and plant species of Community interest whose conservation requires the designation of special Habitats Directive sites) or Annex IV (animal and plant species of Community interest requiring strict protection) of the Habitats Directive, which are to be protected under Article 12 of the Habitats Directive. Harbour porpoises occur in varying densities throughout the year, depending on the area. This also applies to harbour seals and grey seals. In general, it can be assumed that the entire German EEZ of the North Sea belongs to the habitat of the harbour porpoise. The German EEZ is used for transiting, but also for stopping over, and partly also as a feeding and breeding ground.

The occurrence of animals in the individual areas varies greatly both spatially and temporally. For marine mammals and in particular for the strictly protected species harbour porpoise, the effects of implementing the plan must be assessed in terms of species protection law.

In the North Sea EEZ, three nature conservation areas were designated by ordinance in 2017 with the conservation purpose of maintaining and, where necessary, restoring the favourable conservation status of the harbour porpoise, harbour seal and grey seal species according to Annex II of Directive 92/43/EEC. The nature reserve "Sylt Outer Reef - Eastern German Bight" has the function of a nursery area. In the period from 1 May to the end of August, mother-calf pairs are frequently recorded in the area of the "Sylt Outer Reef - Eastern German Bight" nature reserve. The nature reserve "Borkum Riffgrund" is of great importance for harbour porpoises in spring and partly in the first summer months. Significant densities are regularly recorded during this period. The "Doggerbank" nature reserve has a lower occurrence compared to the other two nature reserves. In the Dogger Bank area, animals were recorded mainly in the summer months. Mother-calf pairs also occur. Their presence in the summer months also suggests a function as a breeding area.

In the BMU noise protection concept (2013), a main concentration area of harbour porpoise in the period from 1 May to the end of August within the German Bight was also identified on the basis of data collected in the period from 2002 to 2010. The main concentration area comprises the nature conservation area "Sylt Outer Reef - Eastern German Bight" and is defined as a reserved area for harbour porpoises in the maritime spatial plan due to its special importance for the conservation of the population. The special importance of the reserved area results from the regular occurrence of the harbour porpoise and the presence of mother-calf pairs in the summer months within this area.

The priority areas EN1, EN2 and EN3 have a medium to - seasonally in spring - high importance for harbour porpoises, whereas they have a low to medium importance for grey seals and harbour seals.The reserved area EN4, the priority area EN13 as well as a sub-area of the priority area EN11 (near the nature reserve) have a medium, in summer even a high importance for harbour porpoises due to the new findings and are part of the identified main concentration area of the harbour porpoise in the German North Sea (BMU, 2013). Reserved area EN5 is located in the main concentration area of harbour porpoise and is used by harbour porpoise as both feeding and breeding ground - even though the focus of the concentration is within subarea I of the nature reserve "Sylt Outer Reef - Eastern German Bight". Area EN5 is of high importance in the summer months as part of the harbour porpoise nursery area in the German Bight.

Priority areas EN6 to EN12 are of medium importance for harbour porpoises and of low importance for grey seals and harbour seals. In general, the reserved areas EN4 and EN5 as well as some of the priority areas EN11 and EN13 are of high importance for harbour porpoises. Priority areas EN4 and EN5 are of low to medium importance for grey seals and harbour seals. Priority areas EN11 and EN13 are of low importance for grey seals and harbour seals. Reserved areas EN14 to EN18 are of medium importance for harbour porpoises, and of low importance for grey seals and harbour seals. Reserved area EN19, like the Dogger Bank nature reserve, is of high importance for harbour porpoises in the summer months and marks the edge of a large concentration area east of the British Isles. Reserved area EN19 is of low importance for harbour seals and grey seals.

5.2.1 Sec. 44 para. 1 no. 1 BNatSchG (prohibition of killing and injury)

According to sec. 44 para. 1 no. 1 BNatSchG, killing or injuring wild animals of specially protected species, i.e., among others, animals listed in Annex IV of the Habitats Directive, is prohibited. The species protection assessment pursuant to Article 44(1)(1) BNatSchG refers to the killing and injury of individuals (Gellermann, in: Landmann/Rohmer Umweltrecht, Stand: 91. EL September 2019, Article 44 BNatSchG, marginal no. 51). The assessment is carried out for all areas of Plan EN1 up to and including EN19 together.

The main threats to harbour porpoise mortality in the ASCOBANS Agreement Area, which includes the German EEZ in the North Sea, include bycatch in gillnets and trawl nets, dolphin attacks, depletion of food resources, physiological effects on reproductive capacity and infectious diseases, possibly as a result of contaminants. The study of 1692 mortalities along the UK coast between 1991 and 2010 found that the cause of death was related to infectious diseases in 23% of cases, attacks by dolphins in 19% and bycatch in 17%. A further 15% were starved to death and 4% stranded alive (Evans, 2020).

There is evidence of collisions with ships for at least 21 cetacean species (Evans, 2003, cited in Evans 2020). However, the risk of collision is greatest for large cetacean species, including the fin whale and humpback whale (Evans, 2020). A study on the causes of deaths on the coasts of the British Isles found that about 15% to 20% of baleen whales (fin whale, minke whale) had injuries that could have resulted from collisions with ships. In contrast, only 4% to 6% of small cetaceans such as harbour porpoises and dolphins had similar injuries (Evans, Baines & Anderwald, 2011, cited in Evans, 2020).

According to the current state of knowledge, killing or injury of individual animals as a result of the uses defined in the plan is possible due to the input of impulse sound during pile driving for the foundation of facilities.

For marine mammals and in particular for the strictly protected species harbour porpoise, injuries or even kills could be expected from pile driving for the foundations of offshore wind turbines, transformer stations or other platforms if no avoidance and mitigation measures were taken.

In its statements, BfN regularly assumes that, according to current knowledge, injuries in the form of temporary hearing loss occur in harbour porpoises when animals are exposed to a single-event sound pressure level (SEL) of 164 dB re 1 µPa2/Hz or a peak level of 200 dB re 1 µPa.

According to the BfN's assessment, it is ensured with sufficient certainty that, if the specified limit values of 160 dB for the sound event level (SEL05) and 190 dB for the peak level at a distance of 750 m from the emission point are complied with, it will not be possible for the harbour porpoise to be killed or injured pursuant to Article 44 para. 1 no. 1 of the Federal Nature Conservation Act.

In this context, BfN assumes that suitable means, such as deterrence and soft-start procedures, 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 in the update of the ROP on the basis of existing knowledge, in particular from the enforcement procedures for installations already in operation. The plan lists objectives and principles that provide a framework for downstream planning levels and individual licensing procedures. In the downstream procedures, specifications, orders and requirements are made with regard to the necessary noise protection measures and other avoidance and mitigation measures, by means of which the realisation of the prohibition can be excluded or the intensity of any impairments can be reduced. The measures are strictly monitored in order to ensure with the necessary certainty that the killing and injury provisions of Article 44(1)(1) of the Federal Nature Conservation Act (BNatSchG) do not come into effect.

The update of the plan contains principles according to which the input of noise into the marine environment during the construction of installations is to be avoided in accordance with the state of the art in science and technology and an overall coordination of the construction work of spatially co-located installations is to take place. Noise abatement measures are to be used. On this basis, the BSH may order appropriate concretisation with regard to individual work steps, such as deterrence measures and a slow increase in pile driving energy, by means of so-called "soft start" procedures within the framework of subordinate procedures, the site development plan, the suitability assessment of sites and, in particular, within the framework of the respective individual licensing procedures as well as within the framework of enforcement. The use of deterrence measures and soft-start procedures can 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.

Following the precautionary principle, the implementation of the killing ban can be ruled out by the avoidance and mitigation measures mentioned above. The use of suitable deterrence measures ensures that the animals are located outside the area of 750 metres around the emission point. In addition, the degree of noise reduction required and specified in the draft suitability determination ensures that no lethal or long-term adverse noise impacts are expected outside the area where harbour porpoises are not expected to be present because of the deterrent measures to be implemented.

According to the above, there is sufficient certainty that the prohibition of species protection under Article 44 (1) no. 1 of the Federal Nature Conservation Act will not be fulfilled.

According to the current state of knowledge, neither the operation of the turbines nor the laying and operation of the cabling within the park will have any significant negative impacts on marine mammals that fulfil the killing and injury requirements of Article 44 (1) no. 1 of the Federal Nature Conservation Act (BNatSchG).

Since 2018, the Fauna Guard System has been ordered as a deterrence measure in all construction projects in the German EEZ of the North Sea. The use of the Fauna Guard System is accompanied by strict monitoring measures with good results so far. As part of a research project, the effects of the Fauna Guard System are currently being systematically analysed and - if necessary - the application of the system will be optimised for future construction projects (FaunaGuard Study, 2020, in preparation).

In order to avoid cumulative effects, prohibitions are imposed within the framework of subordinate approval procedures and enforcement to ensure that no animals are injured or killed by several sources of impulse sound input acting at the same time. For example, no pile driving is permitted during the blasting of non-transportable munitions.

As a result, the principles and objectives laid down in the plan and the measures ordered in the context of subordinate procedures, in particular the approval procedures for individual projects, prevent with sufficient certainty the realisation of the prohibitions of species protection under Article 44(1)(1) of the Federal Nature Conservation Act.

Furthermore, according to current knowledge, neither the operation of the turbines, nor the laying and operation of the cabling within the park, nor the laying and operation of the grid connection will have any significant negative impacts on marine mammals that fulfil the killing and injury requirements of Article 44(1)(1) of the Federal Nature Conservation Act.

5.2.2 Sec. 44 para. 1 no. 2 BNatSchG (prohibition of disturbance)

Pursuant to sec. 44 para. 1 no. 2 BNatSchG, it is also prohibited to significantly disturb wild animals of strictly protected species during the breeding, rearing, moulting, hibernation and migration periods, whereby significant disturbance exists if the disturbance worsens the conservation status of the local population of a species.

The harbour porpoise is a strictly protected species according to Annex IV of the Habitats Directive and thus within the meaning of sec. 44 para. 1 no. 2 in conjunction with sec. 7 para. 1 no. 14 BNatSchG. 7 para. 1 no. 14 BNatSchG, so that a species protection assessment must also be carried out in this regard.

The species protection assessment pursuant to Article 44(1)(2) BNatSchG refers to population-relevant disturbances of the local population, the occurrence of which varies in the German North Sea EEZ.

In its statements in the context of licensing and enforcement procedures, the Federal Agency for Nature Conservation (BfN) regularly examines the existence of species-specific disturbance within the meaning of Article 44(1)(2) of the Federal Nature Conservation Act (BNatSchG). It comes to the conclusion that the occurrence of a significant disturbance due to construction-related underwater noise can be avoided with regard to the harbour porpoise as a protected species, provided that the sound event level of 160 dB or the peak level of 190 dB is not exceeded in each case at a distance of 750 m from the emission point and sufficient alternative areas are available in the German North Sea. According to the BfN, the latter should be ensured by coordinating the noise-intensive activities of different project developers with the aim of ensuring that no more than 10 % of the area of the German North Sea EEZ is affected by noise causing disturbance (BMU 2013).

<u>Construction-related impacts of wind energy generation</u>

The temporary execution of the pile driving work is not expected to cause any significant disturbance to harbour porpoises within the meaning of Article 44 (1) no. 2 of the Federal Nature Conservation Act.

According to the current state of knowledge, it is not to be assumed that disturbances that may occur due to sound-intensive construction measures, and provided that avoidance and mitigation measures are implemented, would worsen the conservation status of the local population. A local population comprises those (partial) habitats and activity areas of the individuals of a species that have a spatial-functional relationship sufficient for the habitat (space) requirements of the species. A deterioration of the conservation status is to be assumed in particular if the chances of survival, breeding success or reproductive capacity are reduced, whereby this must be examined and assessed on a species-specific basis for each individual case (cf. legal justification for the BNatSchG amendment 2007, BT-Drs. 11).

Through effective noise abatement management, in particular through the application of suitable noise abatement systems in accordance with the principles and objectives in the update of the plan as well as subsequent orders in the individual approval procedure of the BSH and taking into account the specifications from the noise abatement concept of the BMU (2013), negative impacts of the pile driving work on harbour porpoises are not to be expected.

The decisions of the BSH will include concretising orders that ensure effective noise abatement management through appropriate measures.

In accordance with the precautionary principle, measures to avoid and reduce the effects of noise during construction are specified in accordance with the state of the art in science and technology. The specifications in the subordinate procedures and, in particular, the measures ordered in the planning approval decisions to ensure compliance with the requirements of species protection will be coordinated with the BfN in the course of implementation and adjusted if necessary. The following noise-reducing and environmental protection measures are regularly ordered as part of the planning approval procedures:

- Preparation of a sound prognosis taking into account the site- and plant-specific properties (basic design) before the start of construction,
- Selection of the erection method with the lowest noise level according to the state of the art and the existing conditions,
- Preparation of a concretised soundproofing concept adapted to the selected foundation structures and erection processes for the execution of pile driving works in principle two years before the start of construction, in any case before the conclusion of contracts regarding the sound-relevant components,
- Use of sound-reducing accompanying measures, individually or in combination, away from the pile (bubble curtain system) and, if necessary, also close to the pile, according to the state of the art in science and technology,
- Consideration of the characteristics of the hammer and the possibilities of controlling the pile driving process in the sound insulation concept,
- Concept for the removal of animals from the hazard area (at least within a radius of 750 m around the pile driving site),
- Concept for verifying the efficiency of the deterrence and sound-reducing measures,
- Operating noise-reducing system design according to the state of the art.

As outlined above, deterrence measures and a soft-start procedure must be applied to ensure that animals in the vicinity of the pile-driving work have the opportunity to move away or escape in time.

A measure ordered to avoid the risk of killing pursuant to Article 44(1)(1) of the Federal Nature Conservation Act, such as the scaring away of a species, may in principle also fulfil the prohibition of disturbance if it takes place during the protected periods and is significant (BVerwG, judgment of 27.11.2018 - 9 A 8/17, cited in juris).

Until 2017, a combination of pingers was used as a pre-warning system, followed by the use of the so-called seal scarer as a warning system. All results from monitoring by acoustic detection of harbour porpoises in the vicinity of offshore construction sites with pile driving have confirmed that the use of deterrence has always been effective. The animals have left the danger zone of the respective construction site. However, the use of seal scarers is associated with a large loss of habitat caused by the animals' escape reactions 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 the removal of animals from the danger zone of construction sites, the so-called Fauna Guard System, has been used in construction projects in the German EEZ of the North Sea since 2018. The development of new deterrence systems, such as the Fauna Guard System, opens up the possibility for the first time to adapt the deterrence of harbour porpoises and seals in such a way that the realisation of the killing and realisation elements within the meaning of sec. 44 para. 1 no. 1 BNatSchG can be excluded with certainty without a simultaneous realisation of the disturbance elements within the meaning of sec. 44 para. 1 no. 2 BNatSchG.

The use of the Fauna Guard System is accompanied by 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 (FaunaGuard study, in preparation).

The selection of noise-reducing measures by the subsequent executing agencies of the individual projects must be based on the state of the art in science and technology and on experience already gained in the context of other offshore projects. Practical experience in the application of technical noise-reducing systems and experience with the control of the pile driving process in connection with the characteristics of the impulse hammer were gained in particular during the foundation work in the projects "Butendiek", "Borkum Riffgrund I", "Sandbank", Gode Wind 01/02", "NordseeOne", "Veja Mate", "Arkona Basin Southeast", "Merkur Offshore", "EnBWHohe-See" 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 reduction measures used in German projects to date.

The results from the very extensive monitoring of the construction phase of 20 offshore wind farms have confirmed that the measures to avoid and reduce disturbance of harbour porpoises by pile driving noise are being implemented effectively and that the requirements of the BMU noise protection concept (2013) are being reliably met. The current state of knowledge takes into account 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 of up to 8.1 m. The results of this study show that the impact of pile driving on the harbour porpoise can be prevented effectively and reliably. It has been shown that the industry has found solutions in the various procedures to effectively reconcile installation processes and noise protection.

According to current knowledge and based on the development of technical noise protection to date, it can be assumed that significant disturbance to harbour porpoises can be ruled out from the foundation works within the areas covered by the plan, even assuming the use of piles with a diameter of more than 10 metres.

In addition, the BSH's planning approval decision will order more specific monitoring measures and noise measurements in order to determine a possible hazard potential on site on the basis of the specific project parameters and, if necessary, to initiate optimisation measures.

New findings confirm that the reduction of sound input through the use of technical sound mitigation systems clearly reduces disturbance effects on harbour porpoises. The minimisation of effects relates to both the spatial and temporal extent of disturbance (DÄHNE et al., 2017, BRANDT ET AL. 2016, DIEDERICHS ET AL., 2019).

In order to avoid cumulative impacts due to parallel pile driving at different projects, a temporal coordination of pile driving is ordered within the framework of subordinate planning approval procedures and enforcement in accordance with the requirements of the BMU noise protection concept (2013). The noise protection concept of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) (2013) pursues an area-based approach with the aim of maintaining sufficient high-quality alternative habitats for harbour porpoise stocks in the German EEZ of the North Sea free of disturbance-triggering noise inputs.

Specifically, the cross-project coordination of pile-driving work, including the scouring, ensures that the noise protection values are complied with at 750 m and that at no time is more than 10% of the area of the German EEZ in the North Sea affected by disturbance-triggering inputs of impulse noise. It is assumed that disturbances can occur at an unweighted broadband SEL of 140 dB re 1µPa2S, which would be expected in a radius of approx. 8 km around the respective pile driving site if the noise protection values mentioned above were complied with.

Cumulative impacts on marine mammals, especially harbour porpoises, can occur primarily through noise exposure during the installation of foundations using pulse pile driving. Thus, marine mammals can be significantly affected if pile driving is carried out simultaneously at different locations within the EEZ without equivalent alternative habitats being available.

So far, the realisation of offshore wind farms and platforms has been relatively slow and gradual. In the period from 2009 to 2018 inclusive, pile driving was carried out at twenty wind farms and eight converter platforms in the German North Sea EEZ. Since 2011, all pile driving has been carried out using technical noise reduction measures. Since 2014, the noise protection values have been reliably complied with and even undercut through the successful use of noise reduction systems (Bellmann, 2020 in preparation).

The majority of the construction sites were located at distances of 40 km to 50 km from each other, so that there was no overlapping of noise-intensive pile driving activities 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 work, including the deterrence measures.

The evaluation of the sound results with regard to sound propagation and the possibly resulting accumulation has shown that the propagation of impulsive sound is strongly restricted when effective sound minimising measures are applied (DÄHNE et al., 2017).

Current findings on possible cumulative effects of pile driving on the occurrence of harbour porpoise in the German EEZ of the North Sea are provided by two studies from 2016 and 2019 commissioned by the German Offshore Wind Energy Association (BWO). The two studies evaluated and assessed the extensive data from monitoring the construction phases of offshore wind farms by means of acoustic and visual/digital recording of harbour porpoise across projects (Brandt et al., 2016, Brandt et al., 2018, Diederichs et al., 2019). Effects were assessed in both studies based on the range and duration of harbour porpoise displacement from the vicinity of pile driving sites before, during and after pile driving activities.

The 2019 study, which deals with the evaluation of the data from the period 2014 to 2018 inclusive, concludes that the optimised use of the technical noise abatement measures since 2014 and the resulting reliable compliance with the limit value has not led to any further reduction in the displacement effects on harbour porpoises compared with the phase from 2011 to 2013 with still unoptimised noise abatement systems. The displacement radius determined in both studies is approx. 7.5 km and thus confirms the assumptions from the BMU noise protection concept (2013). However, the most recent study also showed that no reduction in displacement effects could be detected above a sound level of 165 dB (SEL05 re 1µPa2 s at 750 m distance) (Diederichs et al., 2019). The authors of the study put forward various hypotheses for the interpretation of the results, including psychoacoustic reactions of the animals, differences in food availability, effects of displacement using SealScarer and the activity of the respective construction site, but also differences in data quality. The study also assessed data from the construction of a wind farm in the EEZ of a neighbouring state without the use of sound mitigation measures. This showed that displacement and thus disturbance is significantly lower in construction sites with the use of sound mitigation systems than in construction sites without sound mitigation (Diederichs et la. 2019).

According to the current state of knowledge, avoidance and mitigation measures, as already described, are required during pile driving in order to exclude with certainty any significant disturbance of the local population of harbour porpoise.

As a result, if the above-mentioned strict noise protection and noise reduction measures are applied in accordance with the principles and objectives of the plan and the orders in the planning approval decisions, taking into account the noise protection concept of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) (2013) and compliance with the limit value of 160 dB SEL5 at a distance of 750 m, there is no reason to fear any significant disturbance within the meaning of sec. 44 para. 1 no. 2 of the Federal Nature Conservation Act. Furthermore, the requirement cited by BfN to coordinate the timing of noise-intensive construction phases of various project developers in the German North Sea EEZ in accordance with the specifications of the noise protection concept of BMU (2013) is ordered.

Operational effects of wind energy generation

According to current knowledge, the operation of offshore wind turbines is not expected to cause disturbance pursuant to Article 44 (1) no. 2 of the Federal Nature Conservation Act. Based on the current state of knowledge, no negative long-term effects on harbour porpoises due to noise emissions from the turbines are to be expected given the regular construction of the turbines. Any effects are limited to the immediate vicinity of the turbine and depend on the sound propagation in the specific area and, not least, 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 operational noise from offshore wind turbines (LUCKE et al. 2007b): Masking effects were registered at simulated operating noise levels of 128 dB re 1 µPa at frequencies of 0.7, 1.0 and 2.0 kHz. In contrast, no significant masking effects were detected at operating noise levels of 115 dB re 1 µPa. The initial results thus indicate that masking effects due to operating noise can only be expected in the immediate vicinity of the respective installation, whereby the intensity again depends on the type of installation.

Standardised measurements during the operational phase of offshore wind farms in the German EEZ of the North Sea have confirmed that, from an acoustic point of view, the underwater sound outside the wind farm areas is not clearly distinguishable from the permanently present background sound. At a distance of 100 m from the respective wind turbine, only low-frequency noise can be measured. With increasing distance to the turbine, however, the noise of the turbine is only insignificantly differentiated from the ambient sound. Even at a distance of 1 km from the wind farm, higher sound levels are always measured than in the centre of the wind farm. The investigations have clearly shown that the underwater sound emitted by the turbines cannot be clearly identified from other sound sources, such as waves or ship noise, even at short distances. Even the wind farm-related ship traffic could hardly be differentiated from the general ambient sound introduced by diverse sound sources, such as other ship traffic, wind and waves, rain and other uses (MATUSCHEK et al. 2018). Results from current investigations of underwater noise in the operational phase of offshore wind farms are presented in detail in chapter 3.2.4

Results of a study on the habitat use of offshore wind farms by harbour porpoises in operation from the Dutch offshore wind farm "Egmont aan Zee" confirm this assumption. With the help of acoustic recording, the use of the area of the wind farm or of two reference areas by harbour porpoises was considered before the construction of the turbines (baseline recording) and in two consecutive years of the operational 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 operational 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 use of the wind farm area was significantly independent of seasonality and interannual variability. The authors of the study see a direct connection between the presence of the turbines and the increased use by harbour porpoises. They suspect the causes to be factors such as an enrichment of the food supply through a so-called "reef effect" or a calming of the area through the absence of fishing and shipping, or possibly a positive combination of these factors.

The results from the investigations in the operational phase of the "alpha ventus" project also indicate a return to distribution patterns and abundances of harbour porpoise occurrence that are comparable - and in some cases higher - than those from the 2008 baseline survey.

The results from the monitoring of the operational phase of offshore wind farms in the EEZ have so far not yielded clear results. The survey according to the StUK4 by means of aircraft-based recording has so far resulted in 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 CPODs, shows that harbour porpoises use the wind farm areas (Butendiek 2017, Nördlich Helgoland, 2019, Krumpel et al., 2017, 2018, 2019). The two methods - visual/digital detection from aircraft and acoustic detection are complementary, i.e. the results from both methods are to be used to identify and evaluate possible effects. The joint evaluation of the data, the development of suitable evaluation criteria and the description of the biological relevance will be the subject of a research programme.

In order to ensure with sufficient certainty that the disturbance requirement pursuant to Article 44 para. 1 no. 2 of the Federal Nature Conservation Act (BNatSchG) does not come into effect, an operational noise-reducing system design in accordance with the state of the art will be used in line with the corresponding requirement of the subordinate suitability determination and the orders in the individual planning approval decisions.

Appropriate monitoring will also be arranged for the operational phase of the individual projects in the areas covered by the plan in order to record and assess any site- 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 in the areas covered by the plan does not fulfil the prohibition criteria of Article 44 (1) no. 2 of the Federal Nature Conservation Act.

<u>Cumulative view</u>

In Chapter 4.11.3cumulative effects of offshore wind energy production on harbour porpoises were presented and avoidance and mitigation measures were described at the same time. However, the harbour porpoise is exposed to the effects of various anthropogenic uses as well as natural and climate-related changes. A differentiation or even weighting of the share of the impacts caused by a single use on the status of the population is hardly possible scientificallyvvvThe designation of priority areas for wind energy exclusively outside of nature conservation areas represents a measure to ensure the protection of harbour porpoises in the German EEZ. In addition, spatial planning paves the way for downstream planning levels and procedures. Finally, the principles of the plan form the backbone for the specifications in the subordinate procedures and for the orders for the protection of harbour porpoises in the context of individual approval procedures.

The evaluation of current data on the occurrence of harbour porpoise in the German EEZ of the North Sea has shown changes in occurrence and population trends from 2012 to 2018. Results of the large-scale survey of the occurrence in the North Sea have also shown shifts in the stock in the southern North Sea. The authors of the study hypothesise a variety of causes for the observed changes, including pre-exposure to fisheries, pollutant inputs, declining health status, noise inputs from offshore activities and shipping, changes in food supply due to displacement of fish stocks and, of course, cumulative impacts (Gilles et al, 2019).

Spatial planning and the provisions of the plan, including the principles and objectives, are among the central instruments for mitigating or even avoiding cumulative impacts on the harbour porpoise population through the equalisation of spatial conflicts between uses and the designation of priority and reserved areas for nature conservation.

The designation of priority areas for wind energy exclusively outside nature conservation areas is a measure to ensure the protection of harbour porpoises in the German EEZ. In addition, spatial planning paves the way for downstream planning levels and procedures. Finally, the principles of the plan form the backbone for the specifications in the subordinate procedures and for the orders for the protection of harbour porpoises in the context of individual approval procedures.

The noise protection concept of the BMU for the North Sea of 2013 also includes a number of requirements through the habitat approach pursued, which ensure effective avoidance and reduction of cumulative impacts from pile driving on the local population of harbour porpoise in the German EEZ and on the populations in the nature conservation areas. The present plan has identified the main concentration area of harbour porpoise in the German EEZ of the North Sea as a reserved area for harbour porpoise during the sensitive period from 1 May to 31 August, as part of the preparation of the BMU noise protection concept (2013). Within the framework of the subordinate procedures or in individual approval procedures for the uses, the special requirements from the BMU's noise protection concept are ordered in the nature conservation areas as well as in the reserved area.

In conclusion, it can be stated with regard to the harbour porpoise that the implementation of the plan does not fulfil the prohibition criteria of sec. 44 para. 1 no. 1 and no. 2 BNatSchG, also with regard to cumulative impacts.

<u>Other marine mammals</u>

In addition to the harbour porpoise, animal species listed as such in a legal ordinance under Article 54(1) are considered to be specially protected under Article 7(1)(13)(c) of the Federal Nature Conservation Act. In the Federal Ordinance on Species of Wild Fauna and Flora (BArtSchV) issued on the basis of sec. 54 para. 1 no. 1 BNatSchG, native mammals are listed as specially protected and thus also fall under the species protection provisions of sec. 44 para. 1 no. 1 BNatSchG. In principle, the considerations listed in detail for harbour porpoises regarding noise pollution from construction and operation activities of offshore wind turbines apply to all marine mammals otherwise occurring in the areas covered by the Plan. However, among marine mammals, species-specific hearing thresholds, sensitivity and behavioural responses vary considerably. The differences in the perception and evaluation of sound events among marine mammals are based on two components: First, the sensory systems are morphoanatomically as well as functionally species-specific. As a result, marine mammal species hear and react to sound differently. Secondly, both perception and response behaviour depend on the respective habitat (KETTEN 2004).

The areas of the plan are of low to medium importance for harbour seals and grey seals. The nearest frequently frequented haul-out and mooring sites are located at a great distance on Helgoland and on the East Frisian and North Frisian islands.

Seals are generally considered tolerant of sonic activity, especially in the case of an abundant food supply. However, escape reactions during seismic activities have been detected by telemetric studies (RICHARDSON 2004). According to all previous findings, harbour seals can still perceive pile-driving sounds at a distance of more than 100 km. Operating noise from 1.5 - 2 MW wind turbines can still be perceived by harbour seals at a distance of 5 to 10 km (LUCKE K., J. SUNDERMEYER & U. SIEBERT, 2006, MINOSplus Status Seminar, Stralsund, Sept. 2006, presentation).

Overall, it can be assumed that the requirements of species protection can be met due to the large distances to casting and mooring sites as well as the specified measures.

With regard to the harbour seal and grey seal, the avoidance and mitigation measures already listed for the harbour porpoise apply.

In conclusion, it can be stated with regard to harbour seal and grey seal that the implementation of the plan does not fulfil the prohibition criteria of Article 44 para. 1 no. 1 and no. 2 of the Federal Nature Conservation Act, also with regard to other marine mammals.

5.3 Avifauna

Protected bird species of Annex I of the Birds Directive occur in varying densities in the areas identified in the ROP. Against this background, the compatibility of the plan with Article 44(1)(1) of the Federal Nature Conservation Act (prohibition of killing and injury) and Article 44(1)(2) of the Federal Nature Conservation Act (disturbance of strictly protected species and European bird species) must be examined and ensured.

All findings to date indicate that sites EN1, EN2 and EN3 are of medium importance for seabirds, including Annex I species. Site EN4 is only of medium importance for most seabird species, but divers occur there in high densities in spring. Due to its location within the main concentration area of divers, site EN4 is of high importance. Site EN5 is also located in the identified main spring concentration area of divers in the German Bight and is therefore of high importance for the strictly protected divers. Area EN5 and its surroundings have a high occurrence of seabird species, in particular also of protected species of Annex I of the V-Directive such as the disturbance-sensitive divers. The area of sites EN6 to EN13 lies outside concentration centres of various bird species of Annex I of the V-RL such as divers, terns, little gulls and storm-petrels. Areas EN14 to EN19 have a typical high seas bird community with fulmar, kittiwake, razorbill and guillemot.

In addition, parts of the EEZ have an average to above-average importance for bird migration. It is assumed that considerable population shares of the songbirds breeding in northern Europe migrate across the North Sea. However, bird migration guidelines and concentration areas do not exist in the EEZ. There are indications that migration intensity decreases with distance from the coast, but this has not been clarified for the mass of nocturnal migrating songbirds.

Among the uses defined in the ROP, wind energy production is the most intensive use, also with regard to possible impacts on seabirds. At the same time, wind energy production is the only use that is controlled by the BSH within the framework of subordinate procedures. In recent years, the monitoring of the operational phase of offshore wind farms in the German EEZ has increased our knowledge of impacts relevant to species protection.

5.3.1 Sec. 44 para. 1 no. 1 BNatSchG (prohibition of killing and injury)

The species protection assessment pursuant to sec. 44 para. 1 no. 1 BNatSchG relates to the killing and injury of individuals and is therefore carried out uniformly for all areas of Plan EN1 up to and including EN19.

Pursuant to sec. 44 para. 1 no. 1 BNatSchG in conjunction with Art. 5 V-RL, it is prohibited to hunt wild animals of protected species. 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 the species listed in Annex I of the V-RL, species whose habitats and habitats are protected in the nature conservation areas and in the reserved area for divers, as well as characteristic species of the areas in the plan. Accordingly, injury or killing of resting birds as a result of collisions with wind turbines must be excluded. The risk of collision depends on the behaviour of the individual animals and is directly related to the species concerned and the environmental conditions encountered. For example, divers are not expected to collide with wind turbines due to their distinct avoidance behaviour towards vertical obstacles.

In the planning and approval of public infrastructure and private construction projects, it is to be assumed that unavoidable operational killings or injuries of single individuals (e.g. through collision of bats or birds with wind turbines) as realisation of socially adequate risks do not fall under the prohibition (BT-Drs. 16/5100, p. 11 and 16/12274, p. 70 f.). Attribution only occurs if the risk of success is significantly increased by the project due to special circumstances, such as the construction of the installations, the topographical conditions or the biology of the species. In this context, measures for risk avoidance and reduction are to be included in the assessment; cf. LÜTKES/EWER/HEUGEL, SEC. 44 BNATSCHG, MARGINAL NO. 8, 2011; BVERWG, JUDGEMENT OF 12 MARCH 2008; REF. 9 A3.06; BVERWG, JUDGEMENT OF 9 July 2008, ref. 9 A14.07; FRENZ/MÜGGENBORG/LAU, sec. 44 BNATSCHG, MARGINAL NO. 14, 2011.

In its statements on offshore wind farm projects, the BfN regularly states that due to changes in the technical size parameters of the wind turbines in current projects, there is generally an increase in vertical obstacles in the airspace compared to the implementation from 2011 to 2014. However, according to current knowledge, the simultaneous reduction in the number of turbines cannot quantify an increased risk of bird strikes. It is true that collision-related individual losses due to the erection of a fixed installation in previously obstacle-free areas cannot be completely ruled out. However, the measures ordered, such as minimising light emissions, ensure that a collision with the offshore wind turbines is avoided as far as possible or that this risk is at least minimised. In addition, monitoring is carried out during the operational phase to enable an improved nature conservation assessment of the actual bird strike risk posed by the turbines. The order of further measures is also regularly expressly reserved. Against this background, the BSH estimates that there is no significant increase in the risk of death or injury to migratory birds. Consequently, the plan does not violate the prohibition of killing and injury pursuant to Article 44(1)(1) of the Federal Nature Conservation Act. The BfN regularly comes to the same conclusion in its statements on wind farm projects.

According to current knowledge, a site-related significantly increased risk of collision of individual resting bird species in areas EN1 to EN19 of the plan is not identifiable.

It can therefore not be assumed that the prohibition of injury and killing under sec. 44 para. 1 no. 1 BNatSchG has been realised.

5.3.2 Sec. 44 para. 1 no. 2 BNatSchG (prohibition of disturbance)

As explained above, the species of red-throated diver, black-throated diver, lesser black-backed gull, sandwich tern, common tern, Arctic tern, common gull, fulmar, gannet and guillemot, among others, are various native European wild bird species within the meaning of Article 1 of the Birds Directive. Against this background, the compatibility of the plan with Art. 44 para. 1 no. 2 BNatSchG in conjunction with Art. 5 V-RL must be ensured. Art. 5 of the Birds Directive.

According to sec. 44 para. 1 no. 2 BNatSchG, it is prohibited to significantly disturb wild animals of strictly protected species during the breeding, rearing, moulting, hibernation and migration periods, whereby a significant disturbance exists if the disturbance worsens the conservation status of the local population of a species.

The species conservation assessment pursuant to Article 44 (1) no. 2 BNatSchG refers to the population-relevant disturbances of local populations, the occurrence of which varies in the areas covered by the plan. The results of the species conservation law assessment are therefore subsequently presented for individual areas or groups of areas with comparable occurrences.

The species conservation assessment is based on the following considerations related to seabird species according to Annex I of the V-Directive as well as species with a further protection status and those with relatively high abundances in the EEZ:

Common diver (Gavia stellata and Gavia arctica)

Red-throated divers (*Gavia stellata*) and black-throated divers (*Gavia arctica*) are widespread migratory seabird species in the northern hemisphere, with breeding ranges in boreal and arctic areas of Europe, Asia and North America, respectively. The global population of the red-throated diver is estimated at 200,000-600,000 individuals, of which about 42,100-93,000 pairs are in the European breeding population (BIRDLIFE INTERNATIONAL 2015). The black-throated diver is thought to have between 53,800-87,800 breeding pairs in Europe. The global population consists of about 275,000 - 1,500,000 individuals (BIRDLIFE INTERNATIONAL 2015). Both diver species do not breed in Germany, but are mainly found there as migrants during the species-specific migration periods and in winter.

For the assessment of significant disturbance of roosting divers, the local population of divers is to be considered. This is a subset of the NW European winter roosting population, the so-called offshore population of common divers. The NW European biogeographical population, to which the red-throated divers roosting in Germany belong, experienced severe population declines in the years 1970-1990, especially in Russia and Fennoscandia. Despite stable and sometimes increasing population trends, such as in Great Britain, the population has not yet regained its original strength in numbers. Causes for this negative development are anthropogenic and include environmental pollution, such as oil spills. The oil spill from the tanker "Erika" off the French coast caused the death of 248 red-throated divers, among others (CADIOU& DEHORTER 2003). Set net fishing (WARDEN 2010) and the discharge of nutrients into the sea also contribute to the decline of the population. The population of the black-throated diver has suffered equally from these and other encroachments on its natural habitat and has also shown population reductions over the past 30 years. Despite the development of new potential breeding areas, e.g. in north-eastern Poland and Ireland, the population trend of the black-throated diver continues to be downward (BIRDLIFE INTERNATIONAL 2015).

Due to the still not fully recovered or still declining population, both diver species are listed in endangerment categories of some European conservation lists, such as "SPEC 3" ("Widespread species not concentrated in Europe, but showing a negative trend and unfavourable conservation status there"). Moreover, red-throated divers and black-throated divers belong to the species listed in Annex I of the EU's V-Directive and are also listed in the ordinance on the designation of the nature reserve "Sylt Outer Reef - Eastern German Bight".

Apart from the alarming European population trends, red-throated divers and black-throated divers are among the species most susceptible to disturbance.

Red-throated and black-throated divers are among the most sensitive bird species in the German North Sea to shipping traffic. Visual disturbance by ship traffic can cause shying or avoidance reactions. Ship-based bird counts have already shown that divers are disturbed by approaching ships at great distances and fly up (GARTHE et al. 2002). Current findings from studies confirm the scaring effect on divers triggered by ships (MENDEL et al. 2019, FLIESSBACH ET AL. 2019, BURGER ET AL. 2019).

The most common reaction is to fly up. The flight distances vary and can be associated with different individual and ecological factors (FLIEßBACH et al. 2019).

Direct impacts on divers due to visual disturbance are to be expected in particular along busy traffic routes or traffic separation areas, but also in the vicinity of wind farms due to wind farm-related shipping traffic (MENDEL et al. 2019, FLIESSBACH ET AL. 2019, BURGER et al. 2019).

In order to avoid and reduce significant disturbance of the common diver population in spring in their main concentration area by wind farm-related shipping traffic, measures to adapt shipping logistics are being examined. Depending on the location of the wind farm in the main concentration area of the divers, such measures may involve shifting certain recurring maintenance work outside of the spring, reducing the speed or adjusting the route.

As a result, the SEA assessments for the FEP 2019 and FEP 2020 have shown that divers are highly sensitive in terms of population biology, that the main concentration area is of high importance for the conservation of the local population, and that the adverse effects due to avoidance behaviour are intense and permanent.

In order to avoid a deterioration of the conservation status of the local population due to the cumulative impacts of the wind farms, it is necessary to keep the area of the main concentration area currently available to divers, outside the impact zones of already realised wind farms, free of new wind farm projects.

For the detailed assessment, please refer to the species protection assessments for the FEP 2019 and FEP 2020 in Chapter 5 North Sea Environmental Report.

The BSH concludes that significant disturbance within the meaning of Article 44, Paragraph 1, No. 2 BNatSchG as a result of the implementation of the plan can be excluded with the necessary certainty if it is ensured that no additional habitat loss will occur in the main concentration area.

Finally, for offshore wind farms in areas EN1 to EN12, as well as EN14 to EN19, it is not assumed, based on the current state of knowledge, that the disturbance requirement under Article 44(1)(2) of the Federal Nature Conservation Act is met. For the specifications for the extended priority area EN13 and the conditional priority area EN13-North, this assessment can only be made taking into account the overall plan assessment of the ROP (cf. Chapter 7).

Based on the findings on the avoidance behaviour of divers towards offshore wind energy presented in 3.2.5, it must be assumed, according to the current state of knowledge, that the wind farm projects to be realised on EN13 will have a shying effect on the priority area for divers to the extent identified. The same assumptions apply to the conditional priority area EN13-North, insofar as the area becomes a priority area for wind energy from 01.01.2030. Therefore, the extent to which avoidance and mitigation measures must be used must be examined in the individual procedure for the specific turbines applied for.

Little Gull (*Larus minutus*)

The Lesser Black-backed Gull population in Europe is divided into two biogeographical populations. The population breeding from Scandinavia to Russia and partly wintering in the North and Baltic Seas comprises about 24,000 to 58,000 breeding pairs (DELANEY S. & SCOTT D 2006). Other wintering areas extend further south to the Mediterranean and southeast to the Caspian Sea. In Germany, the Lesser Black-backed Gull is mainly found in Lower Saxony and Schleswig-Holstein waters and coastal areas during the main migration seasons (MENDEL et al. 2008).

With regard to possible impairments of the Lesser Black-backed Gull by the wind turbines, the collision risk is to be classified as low. Studies showed that the flight height is mostly below the rotor height (<30m) (Mendel ET al. 2015).

GARTHE & HÜPPOP (2004) classified the Lesser Black-backed Gull as quite insensitive to offshore wind turbines, with a WSI value (wind farm sensitivity index) of 12.8. Studies on potential avoidance behaviour of the Lesser Black-backed Gull do not provide a consistent picture so far.

Due to the relatively low observed densities of the Lesser Black-backed Gull in areas EN1 up to and including EN13, as well as their temporally limited coupling to the species-specific main migration periods, a low to at most medium importance of the areas for the Lesser Black-backed Gull can be assumed. Determinations of the resting population were based on observed maximum densities, which are subject to interannual fluctuations. According to current knowledge, cumulative effects on the population are not to be expected.

Finally, for offshore wind farms in areas EN1 up to and including EN13, it is not assumed, according to the current state of knowledge, that the disturbance requirement under Article 44(1)(2) of the Federal Nature Conservation Act is fulfilled.

Terns

The Sandwich Terns (*Sterna sandvicensis*) breeding in Germany belong to the biogeographical population of Western Europe, whose breeding range also extends along the coastal regions of France, Ireland and Great Britain and to a small extent in the Baltic Sea. The population size is estimated at 160,000 - 186,000 individuals (WETLANDS INTERNATIONAL 2012). Of these, about 9,700 - 10,500 breeding pairs belong to the German breeding stock. During the breeding season, Sandwich Terns move within a radius of 30 - 40 km from their breeding colony. In waters deeper than 20m, there are hardly any foraging Sandwich Terns. The year-round roosting population in the German EEZ is estimated at 110-430 individuals, with even fewer in sub-area II of the nature reserve "Sylt Outer Reef - Eastern German Bight" (MENDEL et. al. 2008).

In general, the population is considered to be stable. In the European Red List, the species is considered "not endangered" (BIRD LIFE INTERNATIONAL 2015).

Arctic terns and common terns (*Sterna paradisea, Sterna hirundo*) occur only sporadically in areas EN1 to EN13 inclusive. Higher, albeit still low, densities were only found near the coast in the course of long-range flight transect surveys (IFAÖ et al. 2015, BIOCONSULT SH 2015).

In general, terns seem to avoid the area inside a wind farm, but are not driven away completely, but shift their stays to the outer areas (PETERSEN et. al. 2006).

Based on the available information, the BSH does not expect any disturbance of the tern population due to offshore wind farms. In conclusion, according to the current state of knowledge, it is not assumed that offshore wind farms in areas EN1 to EN13 fulfil the requirements of Article 44(1)(2) of the Federal Nature Conservation Act.

Alcove birds

Common Guillemot (*Uria aalge*)

The Common Guillemot is one of the most common seabird species in the Northern Hemisphere, with a breeding population in Europe of around 2.35 - 3.00 million individuals. The main breeding areas are on the rocky coasts of Iceland and the British Isles, the latter with about 1.4 million individuals (BIRDLIFE INTERNATIONAL 2015). Studies of ringed guillemots showed that individuals from these large colonies migrate to the southern and eastern North Sea in the post-breeding season to forage (TASKER et al. 1987).

The only breeding colony of Common Guillemot in the German North Sea is on Heligoland. The breeding population was estimated at about 2600 pairs in 2012 (GRAVE 2013). In summer, the animals mostly stay in the immediate vicinity of the breeding colony; within a radius of 30 km, they only occur in low densities. In autumn and winter, Common Guillemots increasingly spread to the offshore area with water depths between 40 - 50 metres (MENDEL et al. 2008).

With a WSI of 12.0, the Common Guillemot belongs to the lower third of the species examined for sensitivity to disturbance by GARTHE & HÜPPOP (2004). The long-term studies since the commissioning of the "alpha ventus" project, on the other hand, have shown a clear avoidance behaviour of the alcove birds (in joint observation with the razorbill). Based on the ship surveys, a reduction in the probability of sightings of up to 75% within the wind farm was observed (BIOCONSULT SH & IFAÖ 2014). The results of the StUKplus project "TESTBIRD" support these observations. During the aerial surveys in the first winter half-years of the operational monitoring (2009/2010 and 2010/2011), no alcids were sighted within the wind farm and within a radius of 1-2 km. From 2012 onwards, alcids were observed for the first time in the outer area of the wind farms (MENDEL et al. 2015).

Based on current knowledge, significant impacts on the population of Common Guillemot caused by offshore wind farms are not to be expected due to the large overall population and the wide geographical distribution. Finally, according to the current state of knowledge, offshore wind farms in areas EN1 up to and including EN13 are not expected to fulfil the requirements for disturbance under Article 44(1)(2) of the Federal Nature Conservation Act.

Razorbill (*Alca torda*)

The razorbill is another frequently observed alcove bird in the North Sea, along with the guillemot. The European population is estimated at about 1 million individuals. The largest proportion, about 60%, breed on rocky coasts of Iceland, followed by other important breeding areas on the British Isles and in Norway (BIRDLIFE INTERNATIONAL 2015). The only breeding colony in Germany is on Helgoland with only about 15 - 20 breeding pairs (GRAVE 2013). Razorbills limit foraging to the immediate vicinity of the breeding site during the breeding season. The winter resting population in the German North Sea is estimated at 7500 individuals. The animals spend more time within the 20 m depth range (MENDEL et al. 2008).

Due to the geographically limited distribution of breeding areas, the Razorbill is listed in the Red List of Breeding Birds (SÜDBECK et al. 2008) in category "R" (species with geographical restriction). However, the breeding colony on Helgoland is very small and will probably not be decisive for the occurrence of the Razorbill in the German North Sea.

The BSH does not currently have any information that would indicate that a disturbance pursuant to Article 44(1)(2) of the Federal Nature Conservation Act has occurred. In conclusion, according to the current state of knowledge, it is not assumed that offshore wind farms in areas EN1 up to and including EN13 meet the criteria for disturbance under Article 44(1)(2) of the Federal Nature Conservation Act.

fulmar (*Fulmarus glacialis*)

The fulmar is a typical seabird and is present all year round in the German EEZ. Its main range is offshore beyond the 30m depth contour (MENDEL et al. 2008). The European breeding population is estimated at 3,380,000 - 3,500,000 breeding pairs. The species is listed as "endangered" (EN) or "vulnerable" (VU) in the Pan-European Red List and the EU Red List27 (BIRDLIFE INTERNATIONAL 2015).

So far, little is known 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 any firm conclusions to be drawn. However, a WSI of only 5.8 indicates a very low sensitivity to disturbance (GARTHE & HÜPPOP 2004).

According to current knowledge, significant impacts on the population of the fulmar caused by offshore wind farms are not to be expected. In conclusion, according to current knowledge, offshore wind farms in areas EN1 up to and including EN13 are not expected to fulfil the requirements for disturbance under Article 44(1)(2) of the Federal Nature Conservation Act.

Gannet *(Sula bassana)*

The breeding population of the gannet in Europe is estimated at around 683,000 breeding pairs (BIRDLIFE INTERNATIONAL 2015). In the German Bight, Heligoland is the only breeding site of the gannet. Other European breeding areas are e.g. along the Norwegian coast and on the well-known Scottish island of Bass Rock. As a highly mobile species, the gannet uses extensive feeding habitats within a radius of up to 120 km from the breeding colony (MENDEL et al. 2008). Although the Gannet shows a wide-ranging (isolated) occurrence, it is listed in the Red List in the category "R" (species with geographical concentration) due to the strong concentration of breeding areas (SÜDBECK et al. 2008). However, its population is considered "not threatened" (least concern, LC) according to European endangerment categories (BIRDLIFE INTERNATIONAL 2015).

For the Northern Gannet, there are few statistically non-significant studies suggesting a potential avoidance behaviour towards wind turbines. Clear statements often fail due to the increased mobility of the species and, similar to the fulmar, the associated low sighting rates and small samples.

With regard to the low, interannually fluctuating occurrence of the gannet, the areas can be assumed to be of low to medium importance as resting and feeding areas.

According to the current state of knowledge, no significant impacts on the population of the Northern Gannet caused by offshore wind farms are to be expected. Finally, according to the current state of knowledge, offshore wind farms in areas EN1 up to and including EN13 are not expected to fulfil the requirements for disturbance under Article 44(1)(2) of the Federal Nature Conservation Act.

Seagulls

Gulls are generally widespread in the North Sea and can be observed nearshore or offshore depending on the species. Recorded densities of the individual species can therefore differ greatly. The most common species, apart from the lesser black-backed gull (already discussed separately), are herring, storm, herring gull, great black-backed gull and kittiwake.

In general, offshore wind turbines seem to attract gulls or not to influence their local distribution. They are also known to be prominent ship-followers. Among gulls, the Common Gull is the only species with an assignment to SPEC category 2 (Species concentrated in Europe with negative population trends and unfavourable conservation status) (BIRDLIFE INTERNATIONAL 2004a). The biogeographical population, which is mainly found in Germany, is estimated to comprise 1,200,000 - 2,000,000 individuals and has a stable population trend (WETLANDS INTERNATIONAL 2012). It is considered "not threatened" in the pan-European Red List and the EU27 list (BIRDLIFE INTERNATIONAL 2015).

According to current knowledge, no significant impacts on the population of the Common Gull caused by offshore wind farms are to be expected. Finally, according to the current state of knowledge, it is not assumed that offshore wind farms in areas EN1 up to and including EN13 fulfil the requirements for disturbance according to sec. 44 para. 1 no. 2 BNatSchG.

Reserved areas for wind energy EN14 to EN19

The seabird monitoring surveys conducted by the FTZ on behalf of the BfN provide information on the seabird community in areas EN14 to EN19 in the so-called "duck's bill". This area is one of the typical habitats of seabird species. Northern fulmars and kittiwakes occur all year round, with a focus in spring and winter, respectively. Razorbills and guillemots are most numerous in winter, the latter also occurring in spring in this remote area of the EEZ. The Dogger Bank area within the German EEZ is part of the foothills of the range of the puffin (*Fratercula arctica*). However, the occurrence within the EEZ is very low (BFN 2017, BORKENHAGEN et al. 2017, BORKENHAGEN ET AL. 2018, BORKENHAGEN ET AL. 2019). The areas lie outside the distribution range of divers in the North Sea EEZ. According to the current state of knowledge, it is not to be assumed that the prohibition status according to sec. 44 para. 1 no. 2 BNatSchG is fulfilled for the species occurring in the areas. A detailed species protection assessment for the reserved areas EN14 to EN19 will be carried out at subordinate levels as further information and findings become available.

Lines

Scaring effects on seabirds, resting birds and migratory birds are limited to the small-scale and very temporally restricted laying of submarine cables and pipelines. These disturbances do not exceed the disturbances generally associated with slow shipping traffic. Therefore, no disturbance relevant under species protection law pursuant to sec. 44 para. 1 no. 2 BNatSchG is to be expected as a result of the specifications for pipelines.

Cumulative effects

In Chapter 4.11.4cumulative effects of offshore wind energy generation on seabirds, in particular on divers, which are sensitive to disturbance, were presented and at the same time the criteria for qualitative assessment of the effects were described. Seabirds are also exposed to the effects of various anthropogenic uses as well as natural and climate-related changes. A differentiation or even weighting of the share of the effects of a single use on the status of the respective population of a species is hardly possible scientifically.

Since 2009, the BSH has carried out qualitative assessments of cumulative effects on divers within the framework of approval procedures for offshore wind farms, using the main concentration area in accordance with the position paper of the BMU (2009). The cumulative consideration of the avoidance behaviour of divers towards offshore wind farms in the context of studies commissioned by the BSH and the BfN resulted in a calculated complete habitat loss of 5.5 km and a statistically significant decrease in abundance up to a distance of 10 km, starting from the periphery of a wind farm (GARTHE et al. 2018). For the statistically significant decrease in abundance, this is not a total avoidance but a partial avoidance with increasing diver densities up to a distance of 10 km from a wind farm.

The priority areas for nature conservation contribute to safeguarding open space, as uses incompatible with nature conservation are excluded in them. This designation is an important measure to ensure the protection of seabird species in the German EEZ. In addition, spatial planning paves the way for further measures, such as the preparation of the land development plan and the preliminary investigation and examination of the suitability of areas for offshore wind energy. Finally, the principles of the plan form the backbone for the specifications in the subordinate procedures and for the orders for the protection of harbour porpoises in the context of individual approval procedures.

The BMU position paper (2009) on the protection of common divers provides the foundation for the assessment of cumulative effects from wind energy generation. The designation of the identified main concentration area as a reserved area for the protection of common divers represents the most important avoidance and mitigation measure to exclude cumulative effects at population level. Due to its special location in the area of the frontal system west of the North Frisian Islands with its very high productivity and the resulting rich food supply, the priority area represents an area protected in addition to the three nature conservation areas for the strictly protected as well as for the characteristic seabird species of the German EEZ in the North Sea.

In addition, military use should impair the conservation purpose of the priority area diver as little as possible. For the period from 1 March to 15 May of a given year, the diver priority area is not to be affected by sand and gravel extraction, and the Federal Armed Forces authorities and the competent nature conservation authority are to reach an agreement on military use (cf. ROP Principle (2) Chap. 2.4 Nature conservation). This takes additional account of the protection of the diver species group, which is sensitive to disturbance, and its particularly important habitat in the North Sea EEZ. The designation of the reserved areas for common divers (StN1 to StN3) also takes account of the sustainable use of the reserved areas EN4 and EN5.

However, according to the current state of knowledge, it must be assumed that the wind farm projects to be realised on EN13 will have a shying effect on the priority area divers to the extent identified and that it must therefore be examined in the individual procedure to what extent avoidance and mitigation measures must be used for the specific turbines applied for.

Finally, for offshore wind farms in areas EN1 to EN12, as well as EN14 to EN19, it is not assumed, based on the current state of knowledge, that the disturbance requirement under Article 44(1)(2) of the Federal Nature Conservation Act is met. For the specifications for the extended priority area EN13 and the conditional priority area EN13-North, this assessment can only be made taking into account the overall plan assessment of the ROP (cf. Chapter 7).

5.4 Bats

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

5.4.1 Sec. 44 para. 1 no. 1 and no. 2 BNatSchG

According to expert knowledge, the risk of isolated collisions with wind turbines cannot be ruled out. In terms of species protection, the same considerations apply in principle as those already mentioned in the assessment of avifauna. According to Art. 12 para. 1 no. 1 a) Habitats Directive, all intentional forms of capture or killing of bat species taken from the wild are prohibited. Collision with offshore structures does not constitute intentional killing. Here, explicit reference can be made to the Guidance on the strict system of protection for animal species of Community interest under the Habitats Directive, which assumes in II.3.6 para. 83 that the killing of bats is an unintentional killing to be continuously monitored under Art. 12 para. 4 of the Habitats Directive. There are no indications for the examination of further facts according to Art. 12 para. 1 of the Habitats Directive.

Experiences and results from research projects or from wind farms that are already in operation will also be given appropriate consideration in further procedures.

The available data for the North Sea EEZ are fragmentary and insufficient to draw conclusions on bat migration. Based on the available data, it is not possible to gain concrete insights into migrating species, migration directions, migration altitudes, migration corridors and possible concentration areas. Previous findings only confirm that bats, especially long-distance migratory species, fly over the North Sea.

However, it can be assumed that any negative impacts of wind turbines on bats will be avoided by the same avoidance and mitigation measures provided for the protection of bird migration.

According to the plans currently envisaged, neither the killing and injury provisions of Article 44(1)(1) of the Federal Nature Conservation Act nor the species protection prohibition of significant disturbance pursuant to Article 44(1)(2) of the Federal Nature Conservation Act are to be expected.

6 Impact assessment / territorial protection assessment

6.1 Legal basis

Insofar as a site of Community importance or a European bird sanctuary may be significantly impaired in terms of its components relevant to the conservation objectives or the purpose of protection, sec. 7 para. 6 in conjunction with sec. 7 para. 7 of the ROG must be applied when amending and supplementing spatial plans. Para. 7 ROG, the provisions of the Federal Nature Conservation Act on the admissibility and implementation of such interventions, including obtaining the opinion of the European Commission, must be applied when amending and supplementing spatial plans.

The Natura2000 network comprises the Sites of Community Importance (SCIs) under the Habitats Directive and the Special Protection Areas (SPAs) under the Birds Directive, which have since been designated as protected areas in Germany (e.g. BVerwG, decision of 13.3.2008 - 9 VR 9/07). The impact assessment carried out here basically takes place at the superordinate level of spatial planning and sets a framework for subordinate planning levels, insofar as these exist. It therefore does not replace the assessment at the level of the concrete project in knowledge of the concrete project parameters, which is carried out within the framework of approval procedures. In this respect, further avoidance and mitigation measures are to be expected if they are deemed necessary by the impact assessment within the framework of approval procedures in order to exclude any impairment of the conservation objectives of Natura2000 sites or the conservation purposes of protected areas by the use within or outside a nature conservation area. At the same time, it must be taken into account that for some uses - especially wind energy - the ROP traces the projects already in operation and the specifications of the FEP sectoral planning, for which impact assessments have already been carried out.

Prior to their designation as marine protected areas under sec. 20 para. 2, 57 of the Federal Nature Conservation Act (BNatSchG), the nature conservation areas in the EEZ were included in the first updated list of sites of Community importance in the Atlantic biogeographical region pursuant to Article 4 para. 2 of the Habitats Directive by decision of the EU Commission of 12.11.2007 (Official Journal of the EU, 15.01.2008, L 12/1), so that an Habitats Impact Assessment had already been carried out as part of the Federal Sectoral Plan Offshore for the German EEZ of the North Sea (BSH 2017). Most recently, an impact assessment according to sec. 34 para. 1 in conjunction with sec. 36 BNatSchG was carried out. 36 BNatSchG was carried out as part of the SEA for the area development plan (BSH, 2020a).

In the German EEZ of the North Sea, there are the nature conservation areas "Sylter Außenriff - Östliche Deutsche Bucht" (Ordinance on the Establishment of the Nature Conservation Area "Sylter Außenriff - Östliche Deutsche Bucht" of 22. September 2017 (NSGSylV)), "Borkum Riffgrund" (Ordinance on the Establishment of the Nature Reserve "Borkum Riffgrund" of 22 September 2017 (NSGBRgV)) and "Doggerbank" (Ordinance on the Establishment of the Nature Reserve "Doggerbank" of 22 September 2017 (NSGDgbV)).

The total area of the three nature reserves in the German EEZ of the North Sea is 7,920 km2, of which 625 km2 belong to the nature reserve "Borkum Riffgrund", 5,603 km2 to the nature reserve "Sylter Außenriff - Östliche Deutsche Bucht" and 1,692 km2 to the nature reserve "Doggerbank".

Within the framework of the impact assessment, 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 biotic communities and species, as well as protected species, specifically fish (river lamprey, fin), marine mammals according to Annex II of the Habitats Directive (harbour porpoise, grey seal and harbour seal) as well as protected bird species according to Annex I of the Birds Directive (in particular red-throated diver, black-throated diver, little gull, Sandwich, common and Arctic tern) and regularly occurring migratory bird species (in particular storm and herring gull, fulmar, gannet, kittiwake, guillemot and razorbill).

The impact assessment carried out here takes place at the superordinate level of spatial planning and sets a framework for subordinate planning levels with regard to long-distance effects, insofar as these exist. It therefore does not replace the assessment at the level of the specific project. Depending on the specifications of the ROP for the respective use, the assessment is graduated. In the case of wind energy, there is a staged planning and approval process. This means that the assessments of the downstream planning levels are taken into account within the framework of this ROP. Insofar as no assessment has yet been carried out within the framework of subordinate planning levels, the assessment is carried out within the framework of this SEA for the ROP on the basis of existing data and knowledge.

There is also a staged planning and approval process for raw material extraction. Where data and knowledge are available, an impact assessment is carried out within the framework of this SEA; otherwise, the assessments are reserved for the downstream planning levels.

The ROP contains specifications relevant to the impact assessment on priority and reserved areas for wind energy, reserved areas for pipelines and reserved areas for hydrocarbons and sand and gravel extraction. The same applies to pipelines.

Scientific determinations can only be examined as far as information is available.

A differentiation must be made for the impact assessment:

<u>Wind energy</u>

Since, according to sec. 5 para. 3 sentence 2 no. 5 a) WindSeeG, areas and sites for wind energy plants may not be designated in the FEP within a protected area designated pursuant to Section 57 BNatSchG, the ROP-E does not contain any area designations for the use of wind energy within the protected areas designated by ordinance.

In the following, the impact assessment therefore refers exclusively to area designations at or in the vicinity of protected areas established by ordinance.

For areas EN1 to EN13, please refer to the impact assessment of the FEP 2019 and FEP 2020.

<u>Raw material extraction</u>

The reserved areas for sand and gravel extraction SKN1 and SKN2 are located within the protected area "Sylt Outer Reef - Eastern German Bight" and the reserved area for hydrocarbons KWN1 is partially located within and otherwise spatially adjacent to the nature conservation area "Dogger Bank".

Where operating plans have already been issued, e.g. for the OAMIII main operating plan in the SKN1 reserved area for sand and gravel extraction, an assessment of compatibility has already taken place. Therefore, no separate assessment is carried out in this SEA.

In all other respects, the examination of compatibility is reserved for the downstream procedures, i.e. in particular the procedures for applying for a main operating plan.

<u>Lines</u>

The reserved area LN6 crosses the nature reserve "Borkum Riffgrund". The reserved areas LN1 and LN14 run within the protected area "Doggerbank".

Scientific uses

The reserved area FoN2 lies within the nature reserve "Sylt Outer Reef - Eastern German Bight". As this only involves sampling of fish and thus selective activities without additional pressures, no impact assessment is carried out. Reference is made to Chapter 4.6.

According to sec. 34 para. 2 in conjunction with sec. 36 BNatSchG, the plan is inadmissible. Section 36 of the Federal Nature Conservation Act (BNatSchG), the plan is inadmissible if the impact assessment shows that the specifications may lead to significant impairments of a Natura 2000 site in its components relevant to the conservation objectives or the purpose of protection.

Projects and plans located outside protected areas must also be examined for their compatibility with the conservation purpose of the respective ordinance as so-called "surrounding projects" (LANDMANN/ROHMER, sec. 34 BNatSchG, marginal no. 10) (cf. e.g. sec. 5 para. 4 NSGBRgV).

6.2 Compatibility assessment with regard to habitat types

Due to the exclusion of designations of areas and sites for wind energy in the nature conservation areas in the FEP, construction, installation and operational impacts on the FFH habitat types "reef" and "sandbank" with their characteristic and endangered biotic communities and species can be excluded. The areas are located far outside the drift distances discussed in the literature, so that no release of turbidity, nutrients and pollutants is to be expected that could impair the nature conservation and FFH areas in their components relevant to the conservation objectives or the conservation purpose.

Whether the specifications lead to impairments of habitat types must be assessed prognostically, taking into account project-specific effects.

For the sections of the pipeline corridors LN1 and LN14 located in the area of the habitat type "Sandbanks with only slight permanent overtopping by seawater" (EU Code 1110), it must be ensured that the orientation values for the relative and absolute area loss according to Lambrecht & Trautner (2007) and Bernotat (2013) are not exceeded.

6.3 Assessment of compatibility with regard to protected species

6.3.1 Compatibility assessment according to the ordinance on the designation of the "Borkum Riffgrund" nature reserve

Area description

The nature reserve "Borkum Riffgrund" is located north of the East Frisian islands of Borkum and Juist in the North Sea and has a size of 625 km². The water depths range from 18 to 33 metres. It is part of the interconnected European ecological network "Natura 2000" and registered as a Site of Community Importance (under the identification number DE- 2104301) under the Habitats Directive. The nature reserve borders the Netherlands to the west and the German coastal sea to the south (12 nautical mile limit). It comprises a sandbank formed from relict sediments, which can be regarded as a continuation of the Saale ice-age Oldenburg-East Frisian ground moraine. In the north and east, the demarcation was based on the form and distribution of the communities of the sandbank with predominantly medium to coarse sands.

With the publication in the Federal Gazette on 13 May 2020, the management plan for the nature conservation area "Sylter Außenriff - Östliche Deutsche Bucht" in the German EEZ of the North Sea was officially announced (BAnz AT

13.05.2020 B11, Managementplan für das Naturschutzgebiet "Borkum Riffgrund" (MPBRg)). The implementation of the programme of measures contained in the management plan will be further specified.

Conservation objectives or protective purpose of the nature reserve

The Borkum Riffgrund natural area is a large sandbank with interspersed stone fields and coarse sediments. About half of this sandbank lies in the protected area of the same name and continues from there to the south-east into the Lower Saxony Wadden Sea National Park and to the east. The area is clearly distinguished from its surroundings by the diversity of the seabed. The area is home to a significant and representative occurrence of the FFH-LRT "Sandbanks with only slight permanent overtopping by seawater", which has diverse substrates and structures and is closely intermeshed with rocky reefs (FFH-LRT "Reefs"). This diversity is an important prerequisite for the development of a species- and individual-rich bottom fauna. This provides a rich food basis for fish, which in turn serve as a food source for the FFH species harbour porpoise and grey seal, among others. There are in part close functional interactions between the Borkum Riffgrund National Park and the other marine protected areas in the German North Sea EEZ - the Sylt Outer Reef - Eastern German Bight and Dogger Bank National Parks - as well as with marine protected areas of the coastal federal states and riparian states - especially the Lower Saxony Wadden Sea National Park. In this way, the "Borkum Riffgrund" NSG contributes to the coherence of the Natura 2000 network. Due to its diverse and interconnected habitat structures and high biological diversity, the "Borkum Riffgrund" NSG assumes a special function for the conservation and restoration of its protected assets in the biogeographical region. For example, the sandbank is the starting point for the recolonisation of surrounding sandbanks and functions as a stepping stone (sec. 3 para. 2 no. 4 NSGBRgV) for the networking of benthic species of sandy habitats in the German North Sea. The reefs also assume such a stepping stone function for reef species (BAnz AT 13.05.2020 B11, Managementplan für das Naturschutzgebiet "Borkum Riffgrund"(MPBRg)).

Prior pressures/threats/impacts and anthropogenic activities are mentioned in the standard data sheet under No. 4.3 (SDS 2020, Official Journal of the EU, L 198/41) and in the management plan. According to the information from the Standard Data Sheet, anthropogenic activities take place within the site. These include shipping, military exercises, oil and gas exploration, power lines, fishing, water sports and other uses. Pressures entering the area from outside include marine water pollution and air pollution.

<u>Protected habitats</u>

In the "Borkum Riffgrund" nature reserve, the habitat types listed in Annex I of Directive 92/43/EEC that characterise the area are found in accordance with sec. 3 para. 3 NSGBRgV.

- Sandbanks with only weak permanent overtopping by seawater (EU code 1110) and
- Reefs (EU code 1170),

In order to protect the habitat types mentioned in paragraph 3(1), including their characteristic species, Article 3(4) NSGBRgV sets targets for the conservation or, where necessary, the restoration of the habitats.

1. the ecological quality of the habitat structures and their areal extent,
2. the natural quality of the habitats with largely natural distribution, population density and dynamics of the populations of the characteristic species and the natural expression of their biotic communities,
3. the unfragmented nature and mosaic-like interconnectedness of the habitats and their function as

Regeneration space especially for benthic fauna,

4. the function as a starting point and dispersal corridor for the recolonisation of surrounding areas by the benthic species and communities, and
5. the diverse substrate and habitat structures with their close mosaic-like interlocking of sandy bottom and reef communities as well as small-scale gradients within these communities.

Protected marine mammal species

Three marine mammal species occur in the Natura2000 site "Borkum Riffgrund" in varying degrees of abundance: Harbour porpoise, common seal and grey seal (Official Journal of the European Communities, No. L 198/41, DE2109301, SDS of 07/2020):

Phocoena phocoena (harbour porpoise): Data quality is considered good and is based on surveys. The population in the area numbers between 251 and 500 individuals and thus represents only a share of 0 to 2% of the local population of the German EEZ in the North Sea according to the standard data sheets of 07/2020. The conservation status is given as average due to the previous pressures. The population is not isolated within the range but at the edge of the distribution area. The overall assessment results in a good value.

Phoca vitulina (seal). The data quality is considered poor or a rough estimate. The population in the area numbers between 11 and 50 individuals and represents a small proportion of 0 to 2% of the estimated local population. A good conservation status is given. The population is not isolated within the range. The overall assessment results in a good value.

Halichoerus grypus (grey seal). The data quality is rated as poor. The population is estimated at 0 to individuals. A good conservation status is given. The population is not isolated within the range. The overall assessment results in a good value due to the uncertainties mentioned.

Among marine mammal species, the harbour porpoise has a significant occurrence in the nature reserve and is considered an indicator or key species with regard to the assessment of impacts of the plan from a nature conservation perspective. The BMU's noise protection concept (2013) provides the framework for assessing the impacts of offshore wind farms and associated infrastructure in terms of site protection to meet the requirements arising from the national implementation of the Habitats Directive (92/43/EEC) or the BNatSchG. Also in the context of the implementation of the Marine Strategy Framework Directive (MSFD, 2008/56/EC), the harbour porpoise is used nationally as well as regionally in the context of the OSPAR and HELCOM Conventions as an indicator species for the assessment of anthropogenic impacts, such as those caused by offshore wind farms. The use of so-called indicator species is a common procedure from a nature conservation perspective to analyse and assess anthropogenic impacts with the necessary depth and to take measures to protect marine habitats and species as required.

Pursuant to sec. 5 para. 6 NSGBRgV, the requirements pursuant to sec. 5 para. 4 NSGBRgV are to be observed in the present audit.

The assessment of the impacts of the plan is based on the conservation purposes of the nearest protected area, "Borkum Riffgrund".

According to Article 3 (1) and (2) NSGBRgV, the general purpose of protection is the permanent preservation of the marine area, the diversity of its habitats, biotic communities and species relevant to this area, as well as the particular diversity of the seabed and its sediments.

Protection shall include the conservation or, where necessary, the restoration of the specific ecological values and functions of the area, in particular its natural hydrodynamics and morphodynamics, a natural or near-natural expression of species-rich gravel, coarse sand and shingle beds, the populations of harbour porpoises, grey seals, harbour seals including their habitats and natural population dynamics, as well as its connecting and stepping stone function for the ecosystems of the Atlantic Ocean, the English Channel and the East Frisian Wadden Sea.

Finally, under Article 3(5)(1) to (5) NSGBRgV, the Ordinance sets out objectives to ensure the conservation and restoration of the marine mammal species listed in Article 3(2) NSGBRgV - harbour porpoise, common seal and grey seal - and to conserve and, where necessary, restore their habitats.

Conservation and restoration:

- 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 exchange opportunities with populations outside the site,
- No. 2: of the area as a largely undisturbed habitat, unaffected by local pollution, of the species of marine mammals referred to in paragraph 3(2) and, in particular, as a habitat of supraregional importance for harbour porpoises in the area of the East Frisian Wadden Sea,
- No. 3: unfragmented habitats and the possibility of migration of the species of marine mammals mentioned in paragraph 3 No. 2 NSGBRgV within, in particular, neighbouring protected areas of the Wadden Sea and off Helgoland,
- No. 4: the essential food resources of the species of marine mammals referred to in paragraph 3(2) of the NSGBRgV, in particular the natural population densities, age class distributions and distribution patterns of the organisms serving as food resources for these marine species of marine mammals; and
- No. 5: a high vitality of individuals and species-typical age structure of fish and cyclostomes populations, as well as the spatial and temporal distribution patterns and population densities of their natural food sources.

The assessment of the impacts of offshore wind energy (Chap. 3 and Chap. 4) has shown that sound input from pile driving during the installation of foundations for offshore wind turbines and platforms can cause significant impacts on marine mammals, in particular harbour porpoise, if no sound protection measures are taken.

The current database on the occurrence of harbour porpoises in the German North Sea EEZ and in the Borkum Riffgrund nature conservation area was presented in Section 2.8.1 and can be described as very good. A very good data basis is also available for the assessment of possible impacts of offshore wind farms based on the results of effect monitoring for compliance with the orders from permits and planning approval decisions.

The proven sensitivity of the harbour porpoise to impulsive noise is crucial for the assessment of the impairment of the site's conservation objectives and for the design of appropriate avoidance and mitigation measures. The particular importance of the harbour porpoise as a key species for the assessment of impacts of offshore wind farms on the living marine environment was also highlighted in the context of defining the noise protection concept for the harbour porpoise in the North Sea (BMU, 2013). According to current knowledge, measures to protect harbour porpoises are effective and suitable to also ensure the protection of harbour seals and grey seals. In particular, it can be assumed that measures to avoid death or injury as well as disturbance of harbour porpoises are also beneficial for the protection of other animal species, e.g. fish.

Areas EN1, EN2 and EN3 of the present update of the plan in the German EEZ are located in the vicinity of the nature reserve "Borkum Riffgrund" (EU code: DE 2104-301).

Reference is made to the results of the impact assessments on the FEP 2019 and FEP 2020.

Possible impairments of the conservation purposes of the nature reserve "Borkum Riffgrund" due to the realisation of projects in areas EN1, EN2 and EN3 of the present plan can be excluded with certainty if the orders in the subordinate individual approval procedures are complied with.

An impact assessment of the update of the plan in areas EN4 to N13, N14 to EN18 and EN19 pursuant to Sections 36, 34 BNatSchG in connection with the conservation purposes of the nature reserve "Borkum Riffgrund" with regard to marine mammals is not required due to the distance of these areas of the plan from the nature reserve.

6.3.2 Compatibility assessment according to the ordinance on the designation of the nature reserve "Sylt Outer Reef - Eastern German Bight" with regard to marine mammals and protected bird species

<u>Area description</u>

The nature reserve "Sylt Outer Reef - Eastern German Bight" has an area of 5,603 km2 and is located in the southern North Sea. It includes the outer reefs off Sylt and Amrum and the moraine ridge of the north-eastern flanks of the Elbe glacial valley. The nature reserve is divided into two areas I and II, with area I comprising the area "Sylt Outer Reef" and area II the area "Eastern German Bight". Area I contains the sub-areas Ia and Ib. The area of Area I is 5311.30 km2, that of Area II 3133.39 km2.

Protective purpose of the area

In sec. 3 NSGSylV, the conservation purpose for the entire nature reserve "Eastern German Bight" is formulated.

According to sec. 3 NSGSylV, the purpose of protection is to

(1) the achievement of the conservation objectives of Natura 2000 sites through the permanent preservation of the marine area, the diversity of its habitats, biotic communities and species relevant to these areas, as well as the special character of the
shallow water areas of the southern North Sea off the North Frisian Islands and the slope areas of the Elbe glacial valley to the west,

(2) the conservation or, where necessary, the restoration of the site's specific ecological values and functions, in particular
   1. its characteristic morphodynamics and the hydrodynamics shaped by the tidal current and the inflow of Elbe water,
   2. a natural or near-natural development of species-rich gravel, coarse sand and shingle beds as well as the development of mud beds with boreal bottom megafauna,
   3. the populations of harbour porpoises, grey seals, harbour seals and seabird species, as well as their habitats and natural population dynamics,
   4. the diverse, species-rich and closely interconnected benthic communities in the central-western area of the protected area (Subarea Ia), which is characterised by a special ecological interlocking of reefs, coarse and medium sands, and benthic communities not or very little influenced by human uses in the area of the Amrum Bank (Subarea Ib), as well as

5. the function for the interconnectedness of the benthic communities in the German Bight.

With the publication in the Federal Gazette on 13 May 2020, the management plan for the nature conservation area "Sylter Außenriff - Östliche Deutsche Bucht" in the German EEZ of the North Sea was officially announced (BAnz AT 13.05.2020 B11, Managementplan für das Naturschutzgebiet "Sylter Außenriff - Östliche Deutsche Bucht"(MPSyl)). The implementation of the programme of measures contained in the management plan will be further specified.

As outlined in the Management Plan, there are close functional interactions between the Sylt Outer Reef - Eastern German Bight Protected Area and the marine protected areas of the coastal federal states and riparian states. There are also interactions with the other marine protected areas in the German EEZ of the North Sea. Due to its size and location, Area I has an important connecting and stepping stone function for the dispersal of benthic species in the German Bight. It represents a link between the biotic communities of the central North Sea and those of the Schleswig-Holstein territorial sea. In particular, the reefs act as stepping stones to the Helgoland reef occurrences and ensure the presence of characteristic species with a large action radius. For the harbour porpoise, the protected area represents an important migration habitat, which is networked with the Dogger Bank, the Borkum Riffgrund and the so-called harbour porpoise sanctuary, among others. Also due to its importance for numerous seabird species, the Sylt Outer Reef - Eastern German Bight SPA contributes to the coherence of the Natura 2000 network (BAnz AT 13.05.2020 B11, MPSyl).

Prior pressures/threats/impacts and anthropogenic activities are mentioned in the Standard Data Sheet under No. 4.3 (SDS 07/2020, Official Journal of the EU, L 198/41) and in the Management Plan. According to the information from the standard data sheet, anthropogenic activities take place within the site. These include sand and gravel extraction, shipping, military exercises, oil and gas exploration, power lines, fishing (pots, baskets, angling), water sports and other uses. Pressures entering the area from outside include marine water pollution and air pollution.

Pursuant to sec. 7 para. 6 NSGSylV, the requirements of sec. 7 para. 1 and para. 4 NSGSylV must be observed for the plan in question, which is to be taken into account in the official decision. Projects and plans shall be assessed for their compatibility with the conservation objectives of a protected area before they are approved or implemented if they are likely, individually or in combination with other projects or plans, to have a significant adverse effect on the nature conservation area.

The assessment of the impacts of the plan is based on the conservation purposes of the nature reserve "Sylter Außenriff - Östliche Deutsche Bucht". According to sec. 1 NSGSylV, the nature reserve combines the FFH area "Sylter Außenriff" and the European bird sanctuary "Östliche Deutsche Bucht" and is divided into two areas according to sec. 2 para. 4. NSGSylV: Area I designates the "Sylt Outer Reef" area, while Area II designates the "Eastern German Bight" area.

According to sec. 3 para. 1 NSGSylV, the purpose of protection is to achieve the conservation objectives of the Natura 2000 sites. According to sec. 3 para. 2 No. 3 NSGSylV, the conservation and restoration of the specific ecological values and functions of the area, in particular the populations of harbour porpoises, grey seals, harbour seals and seabird species, as well as their habitats and natural population dynamics, are to be protected.

<u>Protected habitat types</u>:

For the protection of the habitat types specified in sec. 4 para. 1 no. 1, including their characteristic species, the conservation or, where necessary, the restoration of the following aspects is required in particular:

1. the ecological quality of the habitat structures and their areal extent,
2. the natural quality of these habitats with largely natural distribution, population density and dynamics of the populations of the characteristic species and the natural expression of their biotic communities,
3. the unfragmented nature of the habitats and their function as regeneration areas, especially for benthic fauna; and
4. the function of the site as a starting point and dispersal corridor for the recolonisation of surrounding areas by the benthic species and communities.

Protected marine mammal species

Area I of the nature reserve "Sylter Außenriff - Östliche Deutsche Bucht" is congruent with the Natura2000 site "Sylter Außenriff" (DE 1209-301). Area I has a size of 5,314 km².

Three marine mammal species occur in the Natura2000 site "Sylt Outer Reef" in varying degrees of abundance: Harbour porpoise, common seal and grey seal (Official Journal of the European Communities, No. L 198/41, DE2109301, SDB of 07/2020):

Phocoena phocoena (harbour porpoise): Data quality is considered good and is based on surveys. The population in the area numbers between 1001 and 10000 individuals, with the relative size or density of the population at the site compared to the local population ranging from 15% to 100%. Good conservation is given. The population is not isolated within the range. The overall assessment results in an excellent value.

Phoca vitulina (seal). Data quality is considered to be poor. The population in the area counts between 101 and 250 individuals, with the relative size or density of the population at the site compared to the local population estimated between 0 and 2%. Good conservation is given. The population is not isolated within the range. The overall assessment results in an excellent value.

Halichoerus grypus (grey seal). The data quality is rated as poor. The estimated population at the site is between 11 and 50 individuals and the relative size or density of the population at the site compared to the local population is estimated between 0 and 2%. Good conservation is given. The population is not isolated within the range. The overall assessment results in a good value.

The Natura2000 site "Sylt Outer Reef" is the most important area for harbour porpoises in the German North Sea. The area has a special function as a breeding area for harbour porpoises. Regular sightings of mother-calf pairs in the summer months underline the special importance.

For harbour seals and grey seals, this area is of high importance as a feeding habitat.

In addition, according to current scientific knowledge, the habitat types of Annex I of the Habitats Directive "Reef" (EU code 1170) with a share of 2.9 percent and "Sandbank" (EU code 1110) with a share of 1.7 percent.

Representative and characteristic benthic communities for the habitat types "sandbank" and "reef" occur in the area. With regard to benthic communities, it is a regeneration area that provides a food base for seabirds and fish, among others.

Area I is characterised by great habitat diversity and occurrence of various endangered biotope types. The area is also of international importance as a resting, feeding and wintering habitat for seabirds (Official Journal of the European Communities, No. L 198/41, DE2109301, SDB of 07/2020). In addition to the species listed in Annex II of the Habitats Directive, other characteristic species are also listed in the standard data sheet.

Finally, under Article 4(3)(1) to (5) NSGSylV, the Ordinance lays down objectives to ensure the conservation and restoration of the marine mammal species harbour porpoise, common seal and grey seal mentioned in Article 3(2) NSGSylV, as well as the conservation and restoration of their habitats in Area I.

Conservation and, where necessary, restoration:

- 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, natural genetic diversity within the range population and genetic exchange opportunities with populations outside the range,
- No. 2: of the area as a largely undisturbed habitat, unaffected by local pollution, for the species of marine mammals referred to in paragraph 1(2) and, in particular, as a particularly important breeding, nursery, feeding and migration habitat for harbour porpoises in the southern North Sea,
- No. 3: unfragmented habitats and the possibility of migration of the species of marine mammals referred to in paragraph 1 No. 2 into Danish waters, into the immediately adjacent harbour porpoise sanctuary of the Land Schleswig-Holstein and into the protected areas of the Wadden Sea and off Helgoland,
- No. 4: the essential food resources of the species of marine mammals referred to in paragraph 1 No. 2, in particular the natural population densities, age class distributions and distribution patterns of the organisms serving as food resources for these species of marine mammals; and
- No. 5: a high vitality of individuals and species-typical age structure of fish and cyclostomes populations, as well as the spatial and temporal distribution patterns and population densities of their natural food sources.

Among marine mammal species, the harbour porpoise has a significant occurrence in the nature reserve and is considered an indicator or key species with regard to the assessment of impacts of the plan from a nature conservation perspective. The BMU's noise protection concept (2013) provides the framework for assessing the impacts of offshore wind farms and associated infrastructure in terms of site protection to meet the requirements arising from the national implementation of the Habitats Directive (92/43/EEC) or the BNatSchG. Also in the context of the implementation of the Marine Strategy Framework Directive (MSFD, 2008/56/EC), the harbour porpoise is used nationally as well as regionally in the context of the OSPAR and HELCOM Conventions as an indicator species for the assessment of anthropogenic impacts, such as those caused by offshore wind farms. The use of so-called indicator species is a common procedure from a nature conservation perspective to analyse and assess anthropogenic impacts with the necessary depth and to take measures to protect marine habitats and species as required.

The assessment of the impacts of offshore wind energy (Chap. 3 and Chap. 4) has shown that sound input from pile driving during the installation of foundations for offshore wind turbines and platforms can cause significant impacts on marine mammals, in particular harbour porpoise, if no sound mitigation measures are taken.

The current database on the occurrence of harbour porpoises in the German North Sea EEZ and in the nature reserve "Sylt Outer Reef - Eastern German Bight" was presented in Section 2.8.1 and can be described as very good. A very good data basis is also available for the assessment of possible impacts of offshore wind farms based on the results of effect monitoring for compliance with the orders from permits and planning approval decisions.

The proven sensitivity of the harbour porpoise to impulsive noise is crucial for the assessment of the impairment of the site's conservation objectives and for the design of appropriate avoidance and mitigation measures. The particular importance of the harbour porpoise as a key species for the assessment of impacts of offshore wind farms on the living marine environment was also highlighted in the context of defining the noise protection concept for the harbour porpoise in the North Sea (BMU, 2013). According to current knowledge, measures to protect harbour porpoises are effective and suitable to also ensure the protection of harbour seals and grey seals. In particular, it can be assumed that measures to avoid death or injury as well as disturbance of harbour porpoises are also beneficial for the protection of other animal species, e.g. fish.

The update of the ROP also provides for the designation of a reserved area for harbour porpoises in the German EEZ of the North Sea. The reserved area represents the main concentration area of the harbour porpoise during the sensitive period from 1 May to 31 August, which was identified as part of the development of the BMU noise protection concept (2013). The seasonal reserved area of the harbour porpoise comprises Area I of the nature conservation area "Sylt Outer Reef - Eastern German Bight" and its surroundings. In physical terms, the reserved area thus generously encompasses the area of the frontal system west of the North Frisian Islands. Due to weather and currents, the frontal system spreads very dynamically into the reserved area and ensures increased productivity and rich food supply for TOP predators, such as harbour porpoise and many seabird species. By designating the seasonal reserved area, the maritime spatial plan takes a preventive measure to secure the food-rich alternative habitat of the harbour porpoise outside Area I of the nature reserve.

Nevertheless, according to the current state of knowledge, impacts from sound-intensive pile-driving activities are to be expected in the immediate vicinity of the nature reserve if no sound-preventing and sound-reducing measures are taken. The exclusion of significant impacts, in particular due to disturbance of the populations in the nature reserve and the population of the respective species, requires the implementation of strict noise protection measures. The update of the plan contains a number of principles in this regard. In addition, within the framework of the species protection law assessment, noise protection measures were described according to the state of the art in science and technology, the application of which, according to the current state of knowledge, excludes any significant disturbance of the population in the nature conservation areas.

With regard to areas EN4, EN5, EN11 and EN13, which correspond to areas N-4, N-5, N-11 and N-13, reference is made to the results of the impact assessments on the FEP 2019 and FEP 2020.

The assessment of the potential impacts of the plan has shown that the laying and operation of submarine cable systems will not be associated with any significant adverse impacts on marine mammals in the vicinity of the cable routes. An impairment of the conservation purposes of the nature conservation area "Sylter Außenriff - Östliche Deutsche Bucht" due to the laying and operation of submarine cables within as well as outside the nature conservation area can be ruled out with the necessary certainty, provided that the planning principles of the FEP are observed and appropriate measures are taken within the framework of enforcement.

Any adverse effects on the conservation objectives of Area I of the nature conservation area "Sylt Outer Reef - Eastern German Bight" due to the implementation of projects outside the nature conservation area in areas EN4, EN5, EN11 and EN13 of the present plan can be ruled out with certainty according to the current state of knowledge.

Any adverse effects on the conservation objectives of the nature reserve "Sylt Outer Reef - Eastern German Bight" due to the implementation of projects in the distant areas EN1 to EN3, EN6 to EN10 and EN12 as well as EN14 to EN18 and EN19 of the present plan can be excluded with certainty due to the distance to the nature reserve.

Protected seabird and resting bird species

The EU bird sanctuary "Eastern German Bight" (DE 1011-401) is located west of the North Frisian Wadden Sea and north of the island of Helgoland, and covers an area of 3135.13 km2.

The nature reserve "Sylt Outer Reef - Eastern German Bight" is the most important area for red-throated divers and black-throated divers in the North Sea, offers great habitat and structural diversity with a very rich food supply for seabirds and is characterised by a high diversity of benthic organisms. The southern section is also important as a feeding area for bird species that breed only on Helgoland in Germany. At the same time, it is a concentration area for harbour porpoises and has high ecological value for seals and fish species (species listed in Annex II of the Habitats Directive). The nature reserve is also characterised by occurrences of the habitat types sandbank and reef as well as various endangered biotope types. The standard data sheet lists six bird species of Annex I of the Habitats Directive and twelve regularly occurring migratory bird species not included in Annex I of the Habitats Directive as relevant components of the site (standard data sheet DE 1011 401 of 07/2020, Official Journal of the EU, L 198/41, 4.2 Quality and importance).

According to sec. 5 para. 1 no. 1 NSGSylV, the conservation or, if necessary, the restoration of a favourable conservation status of bird species according to Annex I of the V-Directive as well as of regularly occurring migratory bird species that occur in this area are among the conservation purposes of the nature reserve.

Under sec. 5 para. 1 no. 1 NSGSylV, 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 out objectives for Area II under sec. 5 para 2 no. 1 to no. 4 NSGSylV to ensure the conservation and recovery of the bird species listed in sec. 5 para. 1 NSGSylV and the functions of Area II under paragraph 1.

Conservation and restoration:

- No.1: of the 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; bird species with a negative population trend in their biogeographical population shall be given special consideration,
- No.2: of the main food-bearing organisms of bird species, in particular their natural population densities, age class distributions and distribution patterns,
- No.3: the increased biological productivity at the vertical frontal formations and the geo- and hydromorphological characteristics with their species-specific ecological functions and effects, which are characteristic of the area; and
- No.4: the natural quality of habitats with their respective species-specific ecological functions, their unfragmented nature and their spatial interrelationships, as well as unhindered access to adjacent and neighbouring marine areas.

The ROP update also provides for the designation of a reserved area for common divers in the German EEZ of the North Sea. The reserved area represents the main concentration area of divers during spring in the German EEZ, which was identified as part of the preparation of the BMU position paper (2009). The reserved area comprises Area II of the nature reserve "Sylt

Outer Reef - Eastern German Bight" and its surroundings. In physical terms, the reserved area thus generously encompasses the area of the frontal system west of the North Frisian Islands. Due to weather and currents, the frontal system spreads very dynamically into the reserved area and ensures increased productivity and rich food supply for TOP predators, such as divers but also many other seabird species. By designating the reserved area, the maritime spatial plan takes a preventive measure to safeguard the food-rich alternative habitat of the divers outside Area II of the nature reserve.

With regard to areas EN4, EN5, EN11 and EN13, which correspond to areas N-4, N-5, N-11 and N-13, reference is made to the results of the impact assessments on the FEP 2019 and FEP 2020.

As a result, a significant impairment of the conservation purposes of Area II of the nature conservation area "Sylt Outer Reef - Eastern German Bight" can be ruled out with the necessary certainty through the implementation of the plan with regard to Areas EN11 and EN13.

According to current knowledge, areas EN1 to EN3, EN6 to EN10, EN12, EN14 to EN18 and EN19 are not significant with regard to the occurrence of divers in Area II of the nature reserve "Sylt Outer Reef - Eastern German Bight" due to their distance.

The assessment of the potential impacts of the plan has shown that no significant adverse impacts on bird species in the vicinity of the cable routes will be associated with the laying and operation of submarine cable systems. Adverse effects on the conservation purposes of the nature conservation area "Sylt Outer Reef - Eastern German Bight" due to the laying and operation of submarine cables can be ruled out with the necessary certainty if the planning principles of this plan are adhered to and appropriate measures are taken as part of enforcement.

Significant impairment of the conservation purposes and conservation objectives of Area II of the nature reserve "Sylt Outer Reef - Eastern German Bight" through the implementation of projects in areas EN1 to EN3, EN6 to EN10, EN12, EN14 to EN18 and EN19 can be ruled out due to the distance.

As a result, a significant impairment of the conservation purposes of Area I of the nature reserve "Sylt Outer Reef - Eastern German Bight" can be ruled out with the necessary certainty by implementing the plan and taking into account avoidance and mitigation measures.

6.3.3 Compatibility assessment according to the ordinance on the designation of the "Dogger Bank" nature reserve

Area description

The "Doggerbank" nature reserve was established by the Ordinance of 22 September 2017 ("Ordinance on the Establishment of the "Doggerbank" Nature Reserve", Federal Law Gazette I, I S, 3400").

The "Doggerbank" nature reserve has an area of 1 692 square kilometres and is located in the North Sea in the so-called "duck's bill" of the German EEZ. It encompasses the German part of the largest sandbank in the North Sea, which stretches from the UK continental shelf to the Danish EEZ.

The Dogger Bank is the largest sandbank in the North Sea and extends from the UK continental shelf into the Danish EEZ. The protected area of the same name in the German EEZ includes the German part of the sandbank. The sandbank occupies almost the entire protected area. The water depth is between 28 m and 48 m.

The Dogger Bank represents a biogeographical divide due to its location and the meeting of different water masses: While mainly cold-adapted species are found in the north, species that prefer warmer temperatures dominate in the south. The seafloor is largely composed of fine sands rich in shingle, which are representative of the open offshore sublittoral and serve as a habitat for a diverse benthic community. This provides a rich food base for fish, which in turn are an important food source for the FFH species harbour porpoise and harbour seal, among others (BAnz AT 13.05.2020 B11, Managementplan für das Naturschutzgebiet "Doggerbank"(MPDgb)).

Conservation purpose and objectives

In sec. 3 NSGDgbV, the protective purpose for the entire nature reserve "Eastern German Bight" is formulated. According to sec. 3 NSGDgbV, the purpose of protection is:

(1) the protection of the marine area as a nature conservation area serves to achieve the conservation objectives of the Natura 2000 site by permanently preserving the marine area and the diversity of its biotic communities and species relevant to this area as well as the function of the Dogger Bank as a separating geological structure between the northern and southern North Sea.

(2) the protection referred to in paragraph 1 shall include the conservation or, where necessary, the restoration of the site's specific ecological values and functions, in particular

1. its supra-regionally significant, largely natural hydromorphological conditions, as well as

2. harbour porpoise and harbour seal populations and their habitats and natural habitats

Population dynamics.

The conservation objectives pursued in the nature reserve to maintain or, where necessary, restore a favourable conservation status are formulated in sec. 3 (3) NSGDgbV, as follows:

1. of the habitat type characterising the site according to Annex I of Directive 92/43/EEC Sandbanks with only slight permanent overtopping by seawater (EU code 1110),

2. the species listed in Annex II to Directive 92/43/EEC harbour porpoise (Phocoena phocoena, EU code 1351) and common seal (Phoca vitulina, EU code 1365).

With the publication in the Federal Gazette on 13 May 2020, the management plan for the "Dogger Bank" nature conservation area in the German North Sea EEZ was officially announced (BAnz AT 13.05.2020 B11, Managementplan für das Naturschutzgebiet "Doggerbank"(MPDgb)). The implementation of the programme of measures contained in the management plan will be further specified.

As outlined in the management plan, there are in part close functional interactions between the "Dogger Bank" SPA and the other marine protected areas in the German EEZ of the North Sea - the "Sylt Outer Reef - Eastern German Bight" and "Borkum Riffgrund" SPAs - as well as with marine protected areas of riparian states - in particular protected areas in the area of the Dogger Bank in the EEZs of the Netherlands and Great Britain. In this way, the "Doggerbank" NSG contributes to the coherence of the Natura 2000 network.

Due to the central location of the Dogger Bank in the North Sea and its high biological diversity, the "Dogger Bank" NSG assumes a special function for the conservation and restoration of its protected assets in the biogeographical region. For example, the Dogger Bank National Park is of great importance to harbour porpoises as a migratory, feeding and reproductive habitat. The year-round high biological production in parts of the area is particularly important for reproductive success (BAnz AT 13.05.2020 B11, Managementplan für das Naturschutzgebiet "Doggerbank" (MPDgb)).

Preloads

Prior pressures/threats/impacts and anthropogenic activities are mentioned in the Standard Data Sheet under No. 4.3 (Official Journal of the

EU, L 198/41, MSDS 7/2020,) and in the Management Plan. According to the information from the standard data sheet, anthropogenic activities, shipping and fishing take place within the site. Pressures entering the site from outside include marine water pollution and air pollution.

The plan in question designates areas EN14 to EN18 and EN19 for wind energy production in the indirect vicinity of the "Doggerbank" nature conservation area (EU code: DE 1003-301). This was established by the Ordinance of 22 September 2017 ("Ordinance on the Establishment of the Nature Conservation Area "Doggerbank", Federal Law Gazette I, I S, 3400").

Pursuant to Article 7(6) ROG in conjunction with Articles 36 and 34(2) BNatSchG and Article 5(6) NSGDgbV, the compatibility of projects and plans must be assessed prior to their approval or implementation. If the compatibility assessment shows that one or more of the specifications in the plan may lead to significant impairments of the site's components relevant to the conservation objectives or the conservation purpose, they shall be inadmissible.

The impact of the provisions of the plan is assessed on the basis of the conservation purposes of the "Dogger Bank" conservation area.

Protected habitats

In sec. 3 para.4NSGDgbV, the Ordinance specifies conservation and restoration objectives for the protection of the habitat type mentioned in para.3 no.1, including its characteristic species, as follows:

(1) the ecological quality of the habitat structures and their areal extent,
(2) the natural quality of the habitat with largely natural distribution, population density and dynamics of the populations of the characteristic species and the natural expression of their biotic communities,
(3) the unfragmented nature of the habitat and its function as a regeneration area, especially for benthic fauna,
(4) the high autochthonous biological productivity, as well as
(5) its function as a starting point and dispersal corridor for benthic species in the entire North Sea and its function as a particularly species-rich biogeographical border area between the northern and southern North Sea.

Protected marine mammal species

According to sec. 3 para. 1 NSGDgbV, the purpose of protection is the realisation of the conservation objectives of the Natura2000 site. According to sec. 3 para. 2 no. 2 NSGDgbV, the conservation and restoration of the specific ecological values and functions of the area, in particular the populations of harbour porpoise and harbour seal as well as their habitats, and the natural population dynamics are to be protected.

Two marine mammal species occur in the Natura2000 site "Doggerbank" in varying degrees of abundance: Harbour porpoise and common seal (Official Journal of the European Communities, No. L 198/41, DE2109301, SDB of 07/2020).

Phocoena phocoena (harbour porpoise). The data quality is considered good according to the Standard Data Sheet (Official Journal of the European Union L 198/41, SDS "Doggerbank" 7/2020,) as it is based on data collection. The population in the area counts between 1001 and 10000 individuals. The proportion of the population in the protected area is 2% to 15% of the local population in the German EEZ. Good conservation status is given. The population is not isolated within the range. The overall assessment results in an excellent value.

Phoca vitulina (harbour seal): The quality of data is considered poor. The population in the protected area is estimated at 11 to 50 individuals. The proportion is 0 to 2 % of the estimated local population in the German EEZ. The population is not isolated within the range. The conservation status is good. The overall assessment results in a significant value according to the information from the standard data sheet (SDB "Doggerbank" 7/2020, Official Journal of the European Union).

Under Article 3(1) to (5) NSGDgbV, the Ordinance sets out objectives to ensure the survival and reproduction of the marine mammal species harbour porpoise and harbour seal listed in Annex II of the Habitats Directive (92/43/EEC) and to conserve and restore their habitats.

Conservation and, where necessary, restoration:

- 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 exchange opportunities with populations outside the site,
- No 2: of the area as a habitat for harbour porpoises and harbour seals that is largely undisturbed and unaffected by local pollution and, in particular, as an important feeding, migration, breeding and nursery habitat for harbour porpoises in the area of the central North Sea,
- No. 3: unfragmented habitats and the possibility of migration of harbour porpoises and seals within the German North Sea and into Dutch, British and Danish waters; and
- No. 4: the main foraging organisms of harbour porpoises and harbour seals, in particular their natural population densities, age class distributions and distribution patterns.

The assessment of the potential effects of the Plan update in Chapters 3.2.4and 4.2.5long-distance effects has shown that, based on the knowledge available to date, no significant adverse effects on marine mammals will be associated with the construction and operation of wind turbines or the laying and operation of power lines. This also applies to marine mammals in the reserved areas EN14 to EN18 and EN19 as well as LN1 and LN14.

The proven sensitivity of the harbour porpoise to impulsive noise is crucial for the assessment of the impairment of the site's conservation objectives and for the design of appropriate avoidance and mitigation measures. The particular importance of the harbour porpoise as a key species for the assessment of impacts of offshore wind farms on the living marine environment was also highlighted in the context of defining the noise protection concept for the harbour porpoise in the North Sea (BMU, 2013). According to current knowledge, measures to protect harbour porpoises are effective and suitable to also ensure the protection of harbour seals and grey seals. In particular, it can be assumed that measures to avoid death or injury as well as disturbance of harbour porpoises are also beneficial for the protection of other animal species, e.g. fish.

Based on previous experience in the subordinate planning and approval procedures, avoidance and mitigation measures are ordered for the noise-intensive installation of the facilities in accordance with the specifications of the noise protection concept of the BMU (2013). Particular attention will be paid to the overarching coordination of noise-intensive work to avoid and reduce noise-inducing sound inputs in the area of the nature conservation areas. The data basis with regard to areas EN14 to EN19 is so far considerably smaller than is the case for priority areas EN1 to EN13 or for the nature conservation areas "Borkum Riffgrund" and "Sylter Außenriff - Östliche Deutsche Bucht".

Preliminary investigations are carried out as part of the subordinate procedures, especially for determining the suitability of areas. The results of the preliminary investigations are required both for the examination of the suitability of the areas and for the examination of the need for additional avoidance and mitigation measures or, if necessary, adaptation of the measures in force at the time of the present assessment.The assessment of the impacts of wind energy extraction in Chap. 3 and Chap. 4 has shown that the noise input from pile driving during the installation of foundations for offshore wind turbines and platforms can cause significant impacts on marine mammals, in particular harbour porpoise, if no noise protection measures are taken. The exclusion of significant impacts, in particular through disturbance of the local population of the respective species as well as impairment of the conservation objectives of the nature conservation area, requires the implementation of strict noise protection measures. The plan contains a number of principles in this regard. In the context of the species protection assessment, technical noise protection measures were also described in accordance with the state of the art in science and technology, the application of which, based on current knowledge of the local population in the German EEZ and of the populations in the nature conservation areas and their habitats, would be ruled out. Since 2008, the BSH has introduced orders in its approval notices that include binding limit values for impulsive sound input from pile driving. The introduction of the binding limits is justified by findings on the triggering of temporary hearing threshold shifts in harbour porpoises (Lucke et al., 2008, 2009). Compliance with the limit values (160 dB single sound event level (SEL05) re 1µPa2s and 190 dB re 1µPa at a distance of 750 m) is monitored by the BSH using standardised measurement and evaluation methods.

Since 2011, all pile driving has been carried out using sound mitigation systems. Monitoring of the noise abatement-related measures has shown that they have been very effective since 2014, so that a significant disturbance of the stocks and habitats and an associated impairment of the conservation objectives of the nature conservation areas in the German EEZ of the North Sea can be ruled out.

During installation work at the "Doggerbank" nature reserve, particular care must be taken to ensure that the possibility of migration between habitats in German Dutch, Danish and British waters is given.

Any implementation of the planned specifications, in particular of wind energy in areas EN14 to EN19, is to be expected/assumed well after 2030. In this respect, the technical progress of energy generation in the expected time of implementation can neither be predicted nor described and evaluated.

The goal of climate neutrality in Germany, which has been brought forward to 2045, will require further expansion of renewable energies. For this reason, further areas are also needed in the EEZ for use by offshore wind energy. The German government will therefore commission studies to examine the compatibility of wind power use on the Dogger Bank with nature conservation objectives.

The assessment of the potential effects of the plan has shown that no significant adverse effects on marine mammals in the vicinity of the cable routes will be associated with the laying and operation of cables. An impairment of the conservation purposes of the "Dogger Bank" nature conservation area due to the laying and operation of cables inside as well as outside the nature conservation area can be ruled out with the necessary certainty, provided that the planning principles of the FEP are observed and appropriate measures are taken within the scope of enforcement.

According to the current state of knowledge, any adverse effects on the conservation objectives of the "Dogger Bank" nature conservation area with regard to long-distance effects due to the implementation of projects outside the nature conservation area in areas EN1 to EN13 of the plan in question can be ruled out with certainty due to the distance to the conservation area.

6.3.4 Natura2000 areas outside the German EEZ

The impact assessment also takes into account the long-distance effects of the specifications made within the EEZ on the protected areas in the adjacent 12-nautical-mile zone and in the adjacent waters of the neighbouring states. This also concerns the examination and consideration of functional relationships between the individual protected areas or the coherence of the network of protected areas pursuant to Article 56(2) BNatSchG, since the habitat of some target species (e.g. avifauna, marine mammals) may extend over several protected areas due to their large radius of action.

Specifically, the protected areas "Lower Saxony Wadden Sea National Park" and the EU bird sanctuary "Lower Saxony Wadden Sea and adjacent coastal sea" in the Lower Saxony coastal sea, the "Schleswig-Holstein Wadden Sea National Park", the "Ramsar site Schleswig-Holstein Wadden Sea and adjacent coastal areas", the "Steingrund" FFH area and the "Helgoland seabird sanctuary" in the Schleswig-Holstein coastal sea as well as the Natura2000 area "Sydlige Nordsø" in the Danish EEZ, the Dutch bird sanctuary "Friese Front" and the Dutch FFH area "Doggersbank".

The protection and conservation objectives for the Natura 2000 sites outside the EEZ were taken from the following documents:

- FFH area "Lower Saxony Wadden Sea National Park": sec. 2 i.V.m. Annex 5 Law on the "Lower Saxony Wadden Sea National Park" (NWattNPG) of 11 July 2001 (http://www.lexsoft.de/cgi-bin/lexsoft/niedersachsen_recht.cgi?chosenIndex=Dummy_nv_6&xid=173529,3)
- EU bird sanctuary "Lower Saxony Wadden Sea and adjacent coastal sea": Natura2000 sites of the Tideweser in Lower Saxony and Bremen (http://www.umwelt.bremen.de/sixcms/media.php/13/Fachbeitrag-1_Natura%202000_Teil%203.pdf)
- FFH area "Schleswig-Holstein Wadden Sea National Park and adjacent coastal areas": Conservation objectives for FFH proposal area DE-0916-391 "NTP S-H Wadden Sea and adjacent coastal areas" (http://www.umweltdaten.landsh.de/public/natura/pdf/erhaltungsziele/DE-0916-391.pdf)
- EU bird sanctuary "Ramsar site S-H Wadden Sea and adjacent coastal areas": Conservation objectives for the bird sanctuary DE- 0916-491 "Ramsar site S-H Wadden Sea and adjacent coastal areas" (http://www.umweltdaten.landsh.de/public/natura/pdf/erhaltungsziele/DE-0916-491.pdf)
- "Helgoland seabird sanctuary**":** conservation objectives for the bird sanctuary DE-1813-491 "Helgoland seabird sanctuary" (http://www.umweltdaten.landsh.de/public/natura/pdf/erhaltungsziele/DE-1813-491.pdf)
- FFH site "Steingrund": Conservation objectives for the site designated as a site of Community importance DE 714-391 "Steingrund" (www.umweltdaten.landsh.de/public/natura/pdf/erhaltungsziele/DE-1714-391.pdf)
- Denmark: Habitats Directive and bird sanctuary "Sydlige Nordsø": EUNIS factsheet (http://eunis.eea.europa.eu/sites/DK00VA347)
- The Netherlands: Bird Sanctuary "Friese Front": EUNIS Factsheet (https://eunis.eea.europa.eu/sites/NL2016166)
- Netherlands: FFH site "Doggersbank": EUNIS Factsheet (https://eunis.eea.europa.eu/sites/NL2008001).

The results of the impact assessment in the context of the specifications in the update of the plan pursuant to Section 34 of the Federal Nature Conservation Act in connection with the conservation purposes of the above-mentioned Natura2000 areas with regard to protected species and habitats are also transferable to the Natura2000 areas in the territorial sea. The assessment of possible impairments of the protection purposes and conservation objectives of the Natura2000 sites in the German EEZ came to the conclusion that significant negative impacts can be excluded with the necessary certainty, taking into account the principles and objectives of the maritime spatial plan as well as avoidance and mitigation measures ordered in the context of subordinate approval procedures. This conclusion is also transferable to the protection purposes and conservation objectives of the Natura2000 sites in the coastal sea. The Natura2000 network is structured in German waters in such a way that the connectivity of important habitat types but also functions, such as migration and migration routes in particular, is guaranteed. Appropriate measures for the avoidance and mitigation of significant impacts in the context of subordinate approval procedures in the German EEZ always ensure that no long-distance impacts, including indirect significant impairments of the conservation objectives of the Natura2000 sites in the territorial sea, are to be expected.

6.4 Result of the FFH impact assessment

As a result, significant impairment of the conservation purposes of the nature conservation areas "Borkum Riffgrund", "Sylter Außenriff - Östliche Deutsche Bucht", "Doggerbank" and the conservation purposes of the FFH area "Lower Saxony Wadden Sea National Park" can be ruled out with the necessary certainty by updating the plan, taking into account avoidance and mitigation measures for FHH habitat types, marine mammals, avifauna and other protected animal groups.

It should be noted that the Habitats Directive impact assessment carried out here could not examine project-specific characteristics that are only specified and defined by the developers of projects within the framework of planning approval procedures. The impact assessment is therefore carried out in the context of the planning approval procedure for the respective project, with the aim of deriving and defining the necessary avoidance and mitigation measures at project level.

According to the current state of knowledge, a significant impairment of the Habitats Directive habitat types "reefs" and "sandbanks with only slight permanent overtopping by seawater" can be ruled out even when cumulatively considering the plan and already existing projects for the nature conservation areas "Borkum Riffgrund", "Sylt Outer Reef - Eastern German Bight" and "Dogger Bank" as well as for the "Lower Saxony Wadden Sea National Park" in the coastal sea due to the small-scale impacts on the one hand and the distances to the areas on the other hand.

7 Overall plan assessment

In summary, with regard to the specifications of the maritime spatial plan, the effects on the marine environment are minimised as far as possible through orderly, coordinated overall planning. The protection of the nature conservation areas designated by ordinance as priority areas for nature conservation serves to safeguard the conservation purposes and open space.

The designation of the main diver concentration area, which is larger in area, as a priority area encompassing sub-area II of the nature conservation area "Sylt Outer Reef - Eastern German Bight" may also have a positive impact on other species protected in the nature conservation area or bird sanctuary and their feeding and resting grounds, and takes into account the protection of the diver species group, which is sensitive to disturbance, and its particularly important habitat in the North Sea EEZ. Since other uses (military use, sand and gravel extraction) are to interfere as little as possible with the conservation purpose of the priority area for common divers, and since there is to be no interference from sand and gravel extraction or agreement on military use in the period from 1 March to 15 May of any given year, the protection of common divers is additionally emphasised.

In addition, the exclusion of turbines above the water surface from the definition 2.4 (4) serves to ensure the implementation of measures to safeguard the coherence of the Natura 2000 network (coherence measures) with regard to impairments caused by existing wind turbines in the priority or reserved area for divers. In order to enable nature conservation planning to develop its own compensation scheme in this respect, the temporary designation 2.4 (4) is made as spatial planning support, which temporarily protects the area in question from conflicting uses. This also supports the protection of divers.

Based on the current state of knowledge, it must be assumed that the wind farm projects to be realised on EN13 will have an impact on the priority area divers to the extent identified and that it will therefore be necessary to examine in the individual procedure the extent to which avoidance and mitigation measures must be used for the specific turbines applied for. However, in the overall picture, the positive effects outweigh the negative effects due to the designation of the main concentration area as a priority area for divers beyond the "Sylt Outer Reef - Eastern German Bight" conservation area established by ordinance, and due to the aforementioned stipulations on the consideration of conservation purposes. The designation of the reserved areas for divers (StN1 to StN3) simultaneously takes account of the sustainable use of the reserved areas EN4 and EN5.

Subject to strict compliance with avoidance and mitigation measures, in particular for noise reduction during the construction phase, significant impacts can be avoided, especially through the implementation of the designations for offshore wind energy and power lines. No priority or reserved areas for wind energy are designated in the priority areas for nature conservation. The reserved areas for power lines also run predominantly outside ecologically important areas.

On the basis of the above descriptions and assessments, as well as the assessment of species and site protection, it must be concluded for the Strategic Environmental Assessment, also with regard to any interactions, that, according to current knowledge and at the comparatively abstract level of spatial planning, no significant impacts on the marine environment within the study area are to be expected as a result of the planned specifications.

Many environmental impacts, such as those caused by shipping or fishing, occur independently of the implementation of the maritime spatial plan and can only be controlled to a very limited extent by spatial planning.

Most of the environmental impacts of the individual uses for which specifications are made would also occur - based on the same medium-term time horizon - if the plan were not implemented, since it is not evident that the uses would not take place or would take place to a significantly lesser extent if the plan were not implemented. From this point of view, the provisions of the plan appear fundamentally "neutral" with regard to their effects on the environment. Although it is possible in principle that, due to the concentration/bundling of individual uses on certain areas/territories, some of the provisions of the plan may well have negative environmental impacts in the area of this specific area, an overall balance of the environmental impacts would tend to be positive due to the bundling effects, as the remaining areas/territories are relieved and hazards to the marine environment (e.g. collision risk) are reduced.

For wind energy use, the potential impacts are often small-scale and mostly short-term, as they are limited to the construction phase. So far, there is a lack of sufficient scientific knowledge and uniform assessment methods for the cumulative assessment of impacts on individual protected goods such as bat migration.

For the reserved areas for wind energy and the reserved areas for transmission lines in the area north of the shipping route SN10, detailed data and findings are lacking for individual protected goods. Therefore, the potential impacts cannot be conclusively assessed in the context of this SEA or are subject to uncertainties and require a more detailed review in the context of subsequent planning stages.

8 Measures to avoid, reduce and compensate for significant negative impacts of the maritime spatial plan on the marine environment

8.1 Introduction

Pursuant to No. 2 c) Annex 1 to Section 8 (1) ROG, the environmental report shall contain a description of the measures planned to prevent, reduce and, as far as possible, compensate for significant adverse environmental effects resulting from the implementation of the plan.

In principle, the ROP takes better account of the needs of the marine environment. The provisions of the ROP avoid negative impacts on the marine environment. This is due in particular to the fact that it is not apparent that the uses would not take place or would take place to a lesser extent if the plan were not implemented. The need to develop offshore wind energy and the corresponding connection lines exists in any case and the corresponding infrastructure would have to be created even without the ROP (cf. Chap. 3.2). However, if the plan were not implemented, the uses would develop without the land-saving and resource-saving control and coordination effect of the ROP.

In addition, the provisions of the ROP are subject to a continuous optimisation process, as the insights gained on an ongoing basis during the SEA and consultation process are taken into account in the preparation of the plan.

While individual avoidance, mitigation and compensation measures can already be implemented at the planning level, others only come into effect during concrete implementation and are regulated there in the individual approval procedure on a project- and site-specific basis.

8.2 Measures at plan level

With regard to planning avoidance and mitigation measures, the ROP makes spatial and textual specifications which, in accordance with the environmental protection objectives set out in Chapter 1.4serve to avoid or reduce significant negative impacts of the implementation of the ROP on the marine environment. This essentially concerns

- the designation of all nature conservation areas in the EEZ established by ordinance as priority areas for nature conservation,
- the designation of the main diver concentration area as a diver priority area,
- the designation of the main distribution area of harbour porpoises as a reserved area for harbour porpoises,
- refraining from designating priority or reserved areas for wind energy in priority areas for nature conservation,
- the designation of reserved areas for pipelines, in which pipelines are to be routed, predominantly outside priority areas for nature conservation,
- the principle that consideration should be given to existing nature conservation areas when planning, laying and operating pipelines,
- the principle of noise reduction in the construction of wind turbines,
- the principle of overall coordination of construction work on energy generation plants and the laying of pipelines,
- the principle of choosing the gentlest possible installation method when laying pipes,
- the principle of taking into account best environmental practice according to the OSPAR Convention and the respective state of the art in science and technology,

- the principle of avoiding, as far as possible, the extraction of sand and gravel in the reserved area of divers during the period from 1 March to 15 May,
- and the lowest possible land consumption, ensured by the following principles
    - Economic uses should be as space-saving as possible.
    - After the end of use, fixed installations must be dismantled.
    - When laying pipelines, the aim should be to achieve the greatest possible bundling in the sense of parallel routing. In addition, the routing should be as parallel as possible to existing structures and buildings.

8.3 Measures at the concrete implementation level

In addition to the measures mentioned in Chapter 8.2 at plan level, there are measures for the avoidance and mitigation of insignificant and significant negative impacts in the concrete implementation of the ROP for certain specifications or associated uses, such as offshore wind energy, pipelines and sand and gravel extraction. These mitigation and avoidance measures are specified and ordered by the respective competent approval authority at project level for the planning, construction and operational phases.

With regard to the specific avoidance and mitigation measures for offshore wind energy and power lines, at least the power cables, reference is made to the statements in the environmental report on the FEP 2019 and FEP 2020. These measures, such as noise protection for offshore wind turbines, are described in detail in Chapter 8.

Concrete avoidance and mitigation measures for pipelines include, for example, restrictions on construction times when laying within protected areas, a reduction in light emissions during construction work, the avoidance of riprap as far as possible, and measures to protect cultural and material assets.

For sand and gravel extraction, the concrete avoidance and mitigation measures are derived from the main operating plans. These measures include, for example, a restriction of extraction trips during times that are sensitive for divers, the stipulation that only vessels with a certain sound spectrum be used, the order to exclude certain stone fields or reef types from extraction as well as from impairment by screening, and strict supervision by means of suitable monitoring (cf. Chap. 10.2).

9 Alternative assessment

9.1 Principles of the alternatives assessment

9.1.1 General

A graduated alternatives assessment is carried out for the maritime spatial plan. Depending on the increasingly concrete planning, the alternatives to be examined are reduced in the course of the planning process and become increasingly (spatially) concrete.

In general, according to Art. 5 para. 1 sentence 1 SEA Directive in conjunction with the criteria in Annex I SEA Directive and sec. 40 para. 2 No. 8 UVPG, the environmental report contains a brief description of the reasons for the choice of reasonable alternatives examined.

In describing and assessing the environmental effects determined pursuant to sec. 8 para. 1 ROG, the report shall contain, in accordance with No. 2c Annex 1 to sec. 8 para. 1 ROG, information on the alternative planning options that may be considered, taking into account the objectives and spatial scope of the maritime spatial plan.

At the same time, it also applies to the identification and examination of the planning options or alternative plans to be considered that these can only relate to what can reasonably be required according to the content and level of detail of the maritime spatial plan. The following applies: The greater the expected environmental impacts and thus the requirement for conflict management in planning, the more extensive or detailed investigations are required.

Annex 4 No. 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. At the plan level, therefore, it is primarily the conceptual/strategic design and spatial alternatives that play a role.

In principle, it should be noted that a preliminary assessment of possible and conceivable planning options is already inherent in all specifications in the form of objectives and principles. As can be seen from the justification of the individual objectives and principles, especially those with environmental relevance, the respective determination is already based on a consideration of possible affected public concerns and legal positions, so that a "preliminary examination" of planning options or alternatives has already taken place.

In addition to the zero alternative, the environmental report examines in particular spatial planning options and alternatives as far as they are relevant for the individual uses.

The SEA and thus also the alternatives assessment for the maritime spatial plan are characterised by a greater scope of investigation and a lower level of detail compared to environmental assessments at subsequent planning and approval levels.

9.1.2 Alternative assessment process for the maritime spatial plan

The overarching guidelines initially serve as a framework for the selection and evaluation of the alternatives. In the early stage of the planning process, three planning options were initially developed as overall spatial planning solutions. From these, various sectoral and subspatial planning options were then developed and examined in parallel to the preparation of the draft plans, in accordance with the planning that was taking shape (cfFigure 42).

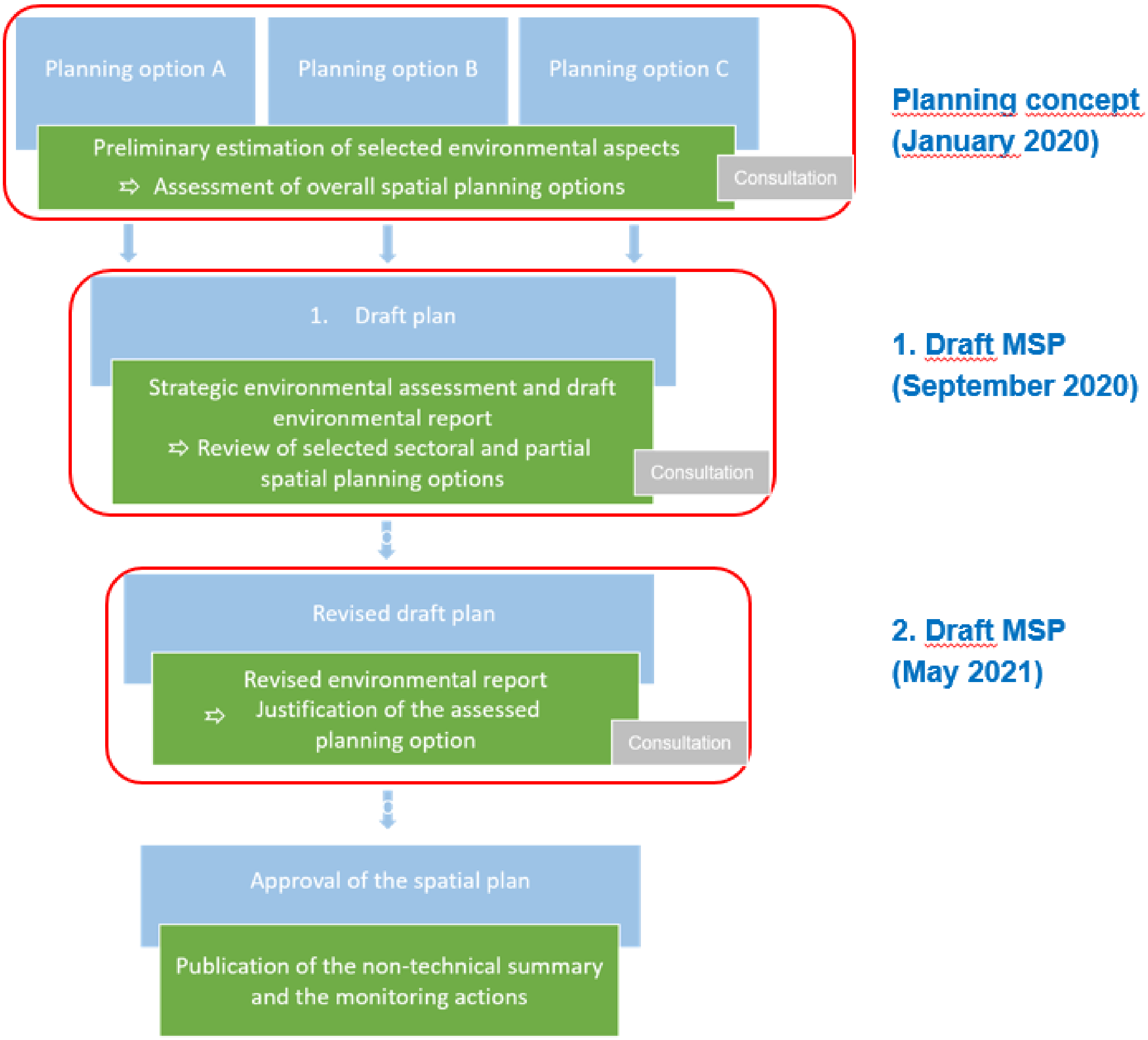


Figure 45: Staged approach in the alternatives assessment

A guiding principle was developed for the maritime spatial plan and guidelines formulated on how the sea can be used and preserved in its diversity. The following overarching objectives can be derived from this, against which the planning alternatives considered below are measured.

<u>The maritime spatial plan shall:</u>

- Support coherent international marine spatial planning and territorial cooperation with other countries and at the regional seas level,
- take into account land-sea relations and planning in the territorial sea,
- lay the foundation for a sustainable marine economy in the spirit of Blue Growth,

- contribute to the protection and enhancement of the state of the marine environment, and to the prevention and reduction of disturbance and pollution.

These objectives are to be achieved through:

- the coordination of current and future spatial demands, with
- the identification of appropriate areas, in particular for economic and scientific uses, but also for marine environmental and other concerns,
- a prioritisation of sea-specific uses and functions,
- the balancing of ecological, economic and social concerns,
- the economical and optimised use of areas allocated to uses, especially areas for fixed infrastructure, which also includes reversibility of fixed installations,
- the holistic view of the different activities in the sea
- with their effects and interactions as well as cumulative effects, and under
- Application of the ecosystem approach and the precautionary principle.

9.2 Examination of alternatives within the framework of the planning concept

The planning concept was prepared as a first informal planning step. At an early stage in the process of updating the maritime spatial plans, the concept for updating the maritime spatial plans in the German EEZ of the North Sea and Baltic Sea comprised three planning options (A-C) as overall spatial plan variants. The early and comprehensive consideration of several planning options represents an essential planning and testing step in the updating of maritime spatial plans.

The concept for the update presents the utilisation demands of different sectors from three different perspectives - in the sense of overall planning alternatives, which are all oriented towards the general framework conditions described above and the basic assumptions listed below, and are thus to be understood as "reasonable" alternatives. In this way, spatial and content-related interdependencies and interactions as well as corresponding planning principles were taken into account and illustrated which maximum demands of individual sectors are thereby limited.

For this concept for the update, a preliminary assessment of selected environmental aspects was already carried out before the preparation of this environmental report. This environmental assessment in the sense of an early examination of variants and alternatives was intended to support the comparison of the three planning options from an environmental perspective.

9.2.1 The planning options at a glance

(A) Planning option A focuses on traditional uses of the sea, with particular attention to the interests of shipping, resource extraction and fishing.

(B) Planning option B shows a climate protection perspective in which a lot of space is given to future use by offshore wind energy.

(C) Planning option C focuses in particular on the wide-ranging and extensive protection of areas for marine nature conservation. In addition to the initially predominantly spatial designations, there are some supplementary textual designations.

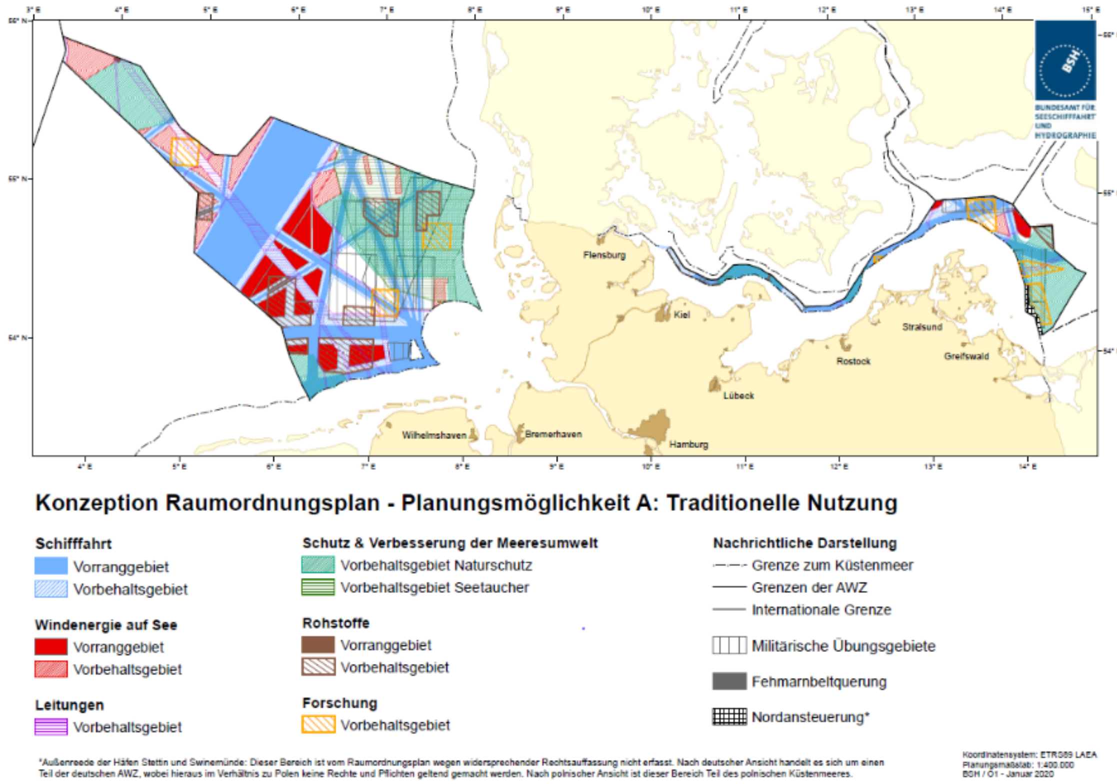


Figure 46: Spatial planning concept - planning option A "Traditional use

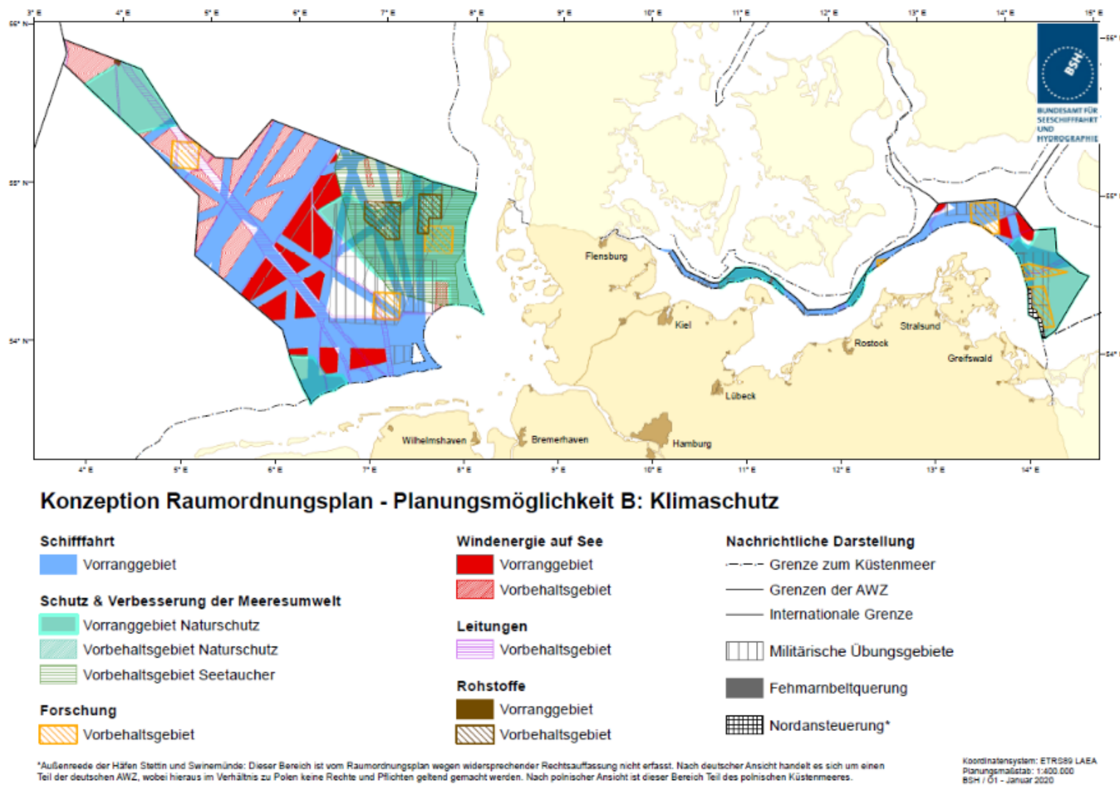


Figure 47: Spatial planning concept - planning option B "Climate protection

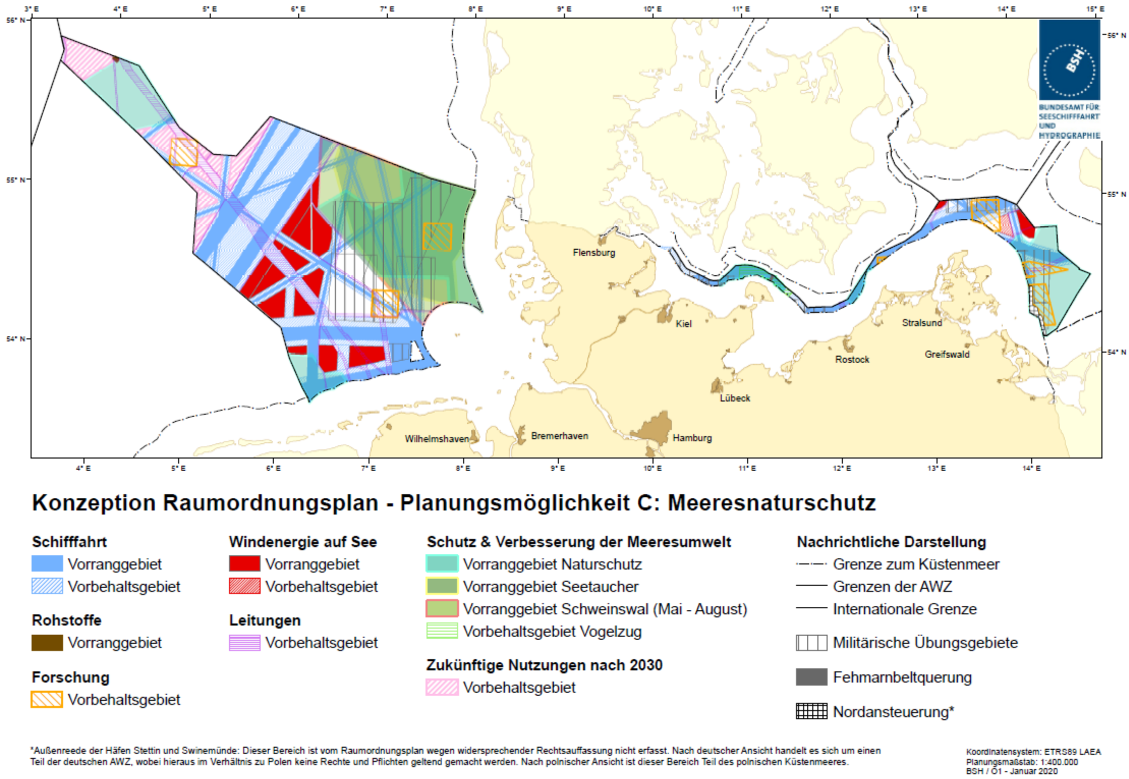


Figure 48: Spatial planning concept - Planning option C "Marine protection

In addition to general basic assumptions and overarching objectives that applied to all three planning options (cf. Concept), the individual planning options were based on the following additional objectives.

Planning option A

Shipping

- Barrier effects must be avoided, especially with regard to the possible establishment of future VTGe, and sufficient space must be secured for this in the long term, especially in Route SN10.

Raw material extraction

- Raw material extraction should also be made possible in conjunction with other uses and in nature conservation areas and should be given special weight in the balancing process. Permit areas according to the BBergG are defined as reserved areas.

Fishing

- For fisheries, opportunities are to be created to limit restrictive effects of uses, especially through further wind energy expansion at sea, and to generate income opportunities through joint use in wind farm areas - this is stated in the text.

Planning option B

Wind energy at sea

- Comprehensive areas are to be secured for the further expansion of offshore wind energy, also beyond 2030, with the largest possible installed capacity for energy generation. For this purpose, area designations for shipping in the course of Route 10 are only planned for the areas of the main traffic flows.
- The future extraction of hydrocarbons, which could affect the expansion of wind energy depending on the location of the extraction facilities, is not supported by

the designation of reserved areas, but permit areas for sand and gravel extraction are taken into account.

Planning option C

Protection and enhancement of the marine environment

- Economic uses in areas for the protection and enhancement of the marine environment which are incompatible with the conservation purpose shall be excluded as far as possible.
- Raw material extraction of sand and gravel, but also of hydrocarbons, should not be privileged, by refraining from spatial designations for all raw materials.
- For bird migration in the Baltic Sea, a reserved area is defined in the area of the Fehmarn-Lolland route.

9.2.2 Environmental assessment of the planning options

In the following table, only those planning topics are listed for which alternative planning solutions have been presented in the planning options. In the assessment of the environmental aspects, impacts are primarily named that relate to the spatial determinations, and here in particular to the differences between the three planning options.

In general, it can be stated that from an environmental perspective, no clear preference for a planning option can be identified. For shipping, differences between the three planning options in terms of environmental impacts cannot be determined at such a coarse level. This is because the same basic assumptions such as traffic volume, ship types and ship classes were used as a basis in all plan variants. For example, the fact that in planning option B wider priority areas are defined within the nature conservation areas does not de facto lead to an increase in shipping traffic in these areas.

For offshore wind energy, there are different spatial specifications between the planning options. Here, the extent of the area specifications varies greatly. From a climate protection perspective, this leads to different levels of CO_2 savings potential. In a relative comparison based on the assumed installed capacity, planning option B offers significantly greater CO_2 savings potential compared to A and C. On the other hand, the three planning options lead to higher CO_2 emissions. On the other hand, the three planning options lead to different land use; it is between 9 % and 20 % of the total North Sea and Baltic Sea EEZ area. This refers to the total area of the defined priority and reserved areas for offshore wind energy. As a rule, however, less than 1 % of the designated areas are actually sealed.

Nature conservation areas make up a large part of the EEZ area. Over one third of the North Sea EEZ and over 50 % of the Baltic Sea EEZ are protected. These are relatively large proportions of land; however, they do not necessarily mean zero use in these areas. The priority areas for nature conservation contribute to safeguarding open space, as uses incompatible with nature conservation are excluded in them. The quantitative differences between the three planning options with regard to the designation of areas for the protection and improvement of the marine environment are rather small. The decisive factor is rather the protection purpose of the designations; for example, the main distribution areas of divers and harbour porpoises are designated as priority areas in individual plan variants. In this respect, from the pure perspective of nature conservation and the precautionary principle, planning option C is to be given preference. However, the climate protection aspect must also be considered here, which is given less consideration in planning option C.

The differences in the area designations and the assessment of selected environmental aspects are presented in detail below.

	Area definitions	Selected environmental aspects
Shipping		
A	Shipping routes as priority areas with accompanying reserved areas;	• Certain displacement and bundling effects are to be expected.
B	All shipping routes in full width priority areas; fanning out of SN10 into three busy main shipping routes, thus leaving intermediate spaces that are shown as reserved areas for offshore wind energy	• Possible increased collision risk with corresponding environmental risks compared to planning options A and C due to reserved areas for wind energy within route SN10, and the concentration of traffic in the remaining corridors, without additional navigation areas.
C	Shipping routes as priority areas with accompanying reserved areas; SN10 along the main traffic flows as a priority area for shipping, with remaining intermediate spaces as a temporary priority area until 2035.	• The temporary priority area does not result in any additional environmental impacts in the medium term compared to planning option A.
Wind energy at sea / Future uses		
A	Designation of areas as priority and reserved areas for offshore wind energy for approx. 35 - 40 GW of installed capacity; Designation of areas EN1 to EN3, and EN6 to EN12 as well as EO1 and EO3 as priority areas for offshore wind energy.	• Land use approx. 5,000 km², approx. 15 % share of North Sea and Baltic Sea EEZs
B	Area designations with more extensive priority and reserved areas for wind energy, also within SN10 for approx. 40 - 50 GW; Designation of areas EN1 to EN3, and EN6 to EN13 as well as EO1 to EO3 as priority areas for offshore wind energy.	• Land use approx. 6,400 km², approx. 20 % share of North Sea and Baltic Sea EEZ, significantly larger than in planning option A. • CO2 savings potential under climate protection aspects: In relation to planning options A and C, the CO2 savings potentials are significantly greater when capacities for installed power are taken into account. • It is possible that a higher collision risk may result from the location of wind energy areas within the main shipping route 10.
C	Designation of areas with a smaller extent of priority and reserved areas for	• In relation to planning options A and B, the CO2 savings potentials already secured for wind energy by the specifications are significantly lower.

	wind energy for approx. 25 -28 GW of installed capacity; Designation of areas EN1 to EN3, and EN6 to EN12 as well as EO1 and EO3 as priority areas for offshore wind energy. In the Duck's Bill, reserved areas are designated for future uses, with wind energy as only one possible use; No designation of areas for wind energy in the reserved areas for divers and harbour porpoises.	• At approx. 3,000 km², the land take for wind energy, approx. 9 % share of the North Sea and Baltic Sea EEZs, is significantly lower than in planning options A and B. • On an area of around 1,600 km² or approx. 6% of the North Sea EEZ, future use is kept open, but no prioritisation is made for offshore wind energy, for example, thus maintaining the option for uses with lower environmental impacts in the long term. • Subsequent use by wind energy at the wind farm sites in the main distribution areas of divers and harbour porpoises is ruled out, so that a positive environmental impact can be expected in the long term compared to the status quo. • Overall, compared to planning options A and B, a significantly stronger weighting of marine nature conservation concerns and thus a potentially lower impact on the marine environment can be expected.
Raw materials		
A	Reserved areas for all permits and for hydrocarbons, and areas for sand and gravel extraction	• Possible disturbance may occur through avoidance effects and potential physical disturbance/injury from underwater sound during seismic surveys. In addition, there would be possible impacts from the construction and operation of production platforms, among others. • Mining in the reserved areas for sand and gravel, all of which are located in nature conservation areas, may result in the following impacts: impairment of the seabed through physical disturbance, impairment and avoidance effects through turbidity plumes, alteration of habitats through removal of substrates.and habitat and area losses.
B	Reserved areas only for sand and gravel extraction	• Fewer impairments than in planning option A are to be expected because only specifications for sand and gravel extraction are envisaged and there is no prioritisation of hydrocarbon extraction by spatial planning.

C	No specifications for raw material extraction	• By foregoing specifications for the extraction of raw materials as a whole, including protected areas, a lower burden can occur compared to planning options A and B, as spatial planning does not specify any prioritisation over other uses here. The use is then based solely on the operational plans according to mining law approval. These may include measures that must be taken to reduce and limit the environmental impacts of the projects as far as possible.
Nature conservation		
A	For nature conservation, reserved areas are shown in the extent of the existing nature conservation areas. In addition, the main concentration area of divers in the North Sea is designated as a reserved area.	• The reservation for nature conservation in the nature conservation areas includes the general exclusion of offshore wind energy, and thus supports the protective purpose of these areas. In the context of further land development for offshore wind energy and a later update of the sectoral planning, nature conservation would only be accorded the weight of a reservation by the regional planning authorities when weighing up the interests. • The reservation for the area of the divers leads to the fact that a subsequent use or the expansion of wind energy - is placed under reservation here.
B	Priority areas for nature conservation are defined in the extent of the existing nature conservation areas, with the exception of the areas that overlap with the reserved areas for sand and gravel extraction. The main concentration area for divers in the North Sea is designated as a reserved area - as in planning option A.	• The designations as priority areas for nature conservation support the conservation purposes of the nature conservation areas. However, where the designations for sand and gravel extraction overlap with the nature conservation area, nature conservation is only assigned a reservation. • Wind energy use in the priority area and in the reserved area for nature conservation remains excluded. • The reservation for the diver area means that a subsequent use is conditional here. • Compared to planning option A, nature conservation is given greater weight in the overall picture.

C	Priority areas for nature conservation are defined in the extent of all nature conservation areas, as well as for the main concentration area of divers and the main distribution area of harbour porpoises (these are limited to the months of May to August). In the area between Fehmarn and Lolland, a reserved area for bird migration is defined.	• The designation of nature conservation areas, as well as the main concentration areas of divers and harbour porpoises, as priority areas for nature conservation supports the conservation purposes of the nature conservation areas and other areas of outstanding nature conservation importance. This gives nature conservation greater weight in the balancing process against other uses within these areas. • The priority of the main concentration area of the common divers leads here to the exclusion of a subsequent use of the existing wind farm areas within the area. In the long term, this could mitigate or compensate for the observed avoidance effects and habitat losses of the common divers. Likewise, wind energy development in the priority area for harbour porpoises is excluded. • The Fehmarn-Lolland bird migration reserve in the Baltic Sea serves as an additional designation to support the MSFD measure for the protection of migratory species.

9.3 Examination of alternatives within the framework of theplanning process

The first draft of the plan was prepared on the basis of the planning concept, the comments received on it and further findings and requirements from informal expert and departmental discussions. The draft plan was revised on the basis of the comments received and coordinated in departmental discussions.

The environmental reports were prepared in parallel to the drafting of the plans. The selection of the alternatives examined was mainly based on the planning options presented and the assessment of the environmental impacts (cf. also Chapter 5 of the concept). The specifications were taken from the respective planning options, but were also spatially adapted in part due to further considerations, or further developed as a combination of various aspects of individual planning options.

In the course of the planning process, the alternatives to be examined were reduced during the revision of the draft plan and became increasingly (spatially) concrete. Thus, the presentation of different alternatives could help to better compare and discuss them in case of conflicting requirements.

It remains the case that the plan is to be considered in the overall context in order to achieve the greatest possible overall balance with other economic and scientific uses and safety concerns in the choice of plan solutions, in addition to taking nature conservation concerns and the avoidance or reduction of possible negative environmental impacts into account. The decisive factor is that the SEA at the level of the specifications made in the maritime spatial plan concludes, based on current knowledge, that no significant impacts on the marine environment are to be expected.

9.3.1 Zero alternative

The zero option, i.e. not updating the ROP, is not a reasonable alternative.

The overarching and forward-looking planning and coordination, taking into account a large number of spatial claims, is expected to lead to a comparatively lower overall land use and thus to lower environmental impacts than if the plan were not implemented (cf. Chapter 3).

Compared to the ROP 2009 and the FEP 2019, the draft plan contains a designation of reserved areas for wind energy for the long-term expansion of offshore wind energy and thus fulfils a precautionary control of the expansion of offshore wind energy. The inclusion of these areas enables spatially ordered and land-saving planning, taking into account environmental concerns and the interests of other uses. This also applies to the designation of reserved areas for pipelines. Whereas in the 2009 ROP only existing pipelines were defined as reserved areas, the current reserved areas include pipelines and, in addition, routes for future connection lines and interconnectors. These reserved areas are predominantly located outside protected areas and thus have a steering effect for the most concentrated routing possible outside sensitive areas.

9.3.2 Spatial alternatives

The following overall or partial spatial alternatives were considered in the preparation of the draft plan.

9.3.2.1 Shipping

Compared to the planning concept, the specifications for shipping in the North Sea represent a combination of different approaches from planning options A, B and C:

- Generally only priority areas for shipping, and in area SN10 main routes highlighted as priority areas without time limits as in planning option B, but no designations for wind energy between these main routes;
- Similar to planning option C, differentiation between main routes and definition of the intermediate areas not as reserved areas, but as temporary priority areas with conditional transition to reserved areas if no traffic management measures are introduced by 2035.

Specifications for offshore wind energy within route SN10 are waived, in particular for reasons of safety and ease of shipping traffic.

This results in a lower impact in this area, which would be expected from the construction and operation of the facilities, including the additional construction and maintenance traffic.

All shipping routes are also designated as priority areas, as in planning option B. In Route SN10, the areas away from the most heavily trafficked areas are designated as temporary priority areas. If no traffic management measures are taken by 2035 that might have to fall back on these areas, they would be "downgraded" to reserved navigation areas.

In contrast to planning option C, however, the general definition of reserved areas for shipping along all shipping routes is dispensed with (cf. further justifications in the draft ROP). The decision not to differentiate between priority and reserved areas for shipping has no influence on potential environmental impacts. The designation of priority areas for shipping within the nature conservation areas reflects the existing traffic flows and serves to keep the routes free.

Shipping traffic does not change de facto as a result of the priority areas for shipping. The number of ship movements in the Sylt Outer Reef is relatively low anyway, while in the Borkum Riffgrund nature reserve the heavily used IMO route Terschelling German Bight had to be taken into account and secured in the spatial planning. The protected area ordinance itself also takes this important function for maritime navigation into account when zoning within the area.

Alternative: Shipping	
Brief description	• The areas for navigation are designated as reserved areas in the entire width of the nature conservation areas.
Presentation of the alternative in comparison to the draft plan	• In the draft plan, all routes are designated as priority areas, including in the nature conservation areas.
Points of conflict with other uses	• According to the provisions of UNCLOS to be applied pursuant to sec. 1 para. 4 ROG, restrictions on shipping in the EEZ are only possible under the conditions laid down therein, so that there can already be no legal conflict of considerations. In addition, sec. 57 para. 3 no. 1 BNatSchG stipulates that restrictions on shipping are not permissible in nature conservation areas. • In particular, in the Borkum Riffgrund NSG, the international shipping route would not be adequately secured by spatial planning in the Terschelling German Bight VTG.
Environmental assessment	• There would presumably be no changes for the environmental impacts from shipping, as there would continue to be freedom of navigation, or in the VTG for the large vessels in the approach to the seaports, the obligation to use it. • No regulations can be made via spatial planning to avoid certain areas, or to change the routing in the nature conservation areas. However, the number of ship movements outside the VTG, especially in the Sylt Outer Reef, is rather small. • The priority areas for shipping primarily serve to keep important shipping routes free of fixed installations and are therefore complementary to the priority areas for nature conservation in their regulatory purpose of avoiding accidents.

9.3.2.2 Wind energy at sea

For offshore wind energy, the spatial specifications from planning option A are used. This option offers sufficient land protection for the objectives of wind energy development.

The definition of priority areas is based not only on the 20 GW legally defined as the expansion target for offshore wind energy, but also on all areas likely to be required for the expansion of offshore wind energy by 2035 (approx. 30 GW) - the medium-term planning horizon of the maritime spatial plan - as priority areas for wind energy (EN1 to EN3, EN6 to EN13).

In addition, areas in zones 4 and 5 (in the "Duck's Bill"), as well as the areas in cluster N-4 and N-5, which are under consideration in the FEP 2019 and in which offshore wind farms have already been or will be built (in the "Helgoland cluster" N-4), are designated as reserved areas for wind energy. For area EN4, there is thus a "downgrading" from a priority area for wind energy compared to the specifications in the 2009 maritime spatial plan.

Current findings from many years of wind farm monitoring are decisive for the designation as reserved areas. These findings have revealed significantly larger-scale avoidance effects and habitat losses for the wind farms located within the diver's main concentration area than had been assumed in the course of the approval and planning procedures.

ROPThe areas north-west of shipping route 10 are shown as reserved areas. This means that they are not conclusively secured for wind energy in their respective extent, but are subject to a weighing up against other significant concerns for this use.

Compared to planning option C, where these areas were designated "future uses", this means a stronger weighting of the use for offshore wind energy. The designation at the spatial planning level appears to be suitable for adequately taking into account the requirements of climate protection and marine nature conservation.

For areas EN9 to EN13, in which no wind turbines have been erected to date, the SEA for the FEP2019 comes to the conclusion that, based on the current status and the application of strict and effective avoidance and mitigation measures, no significant environmental impacts are to be expected, at least at the level of sectoral planning.

For the areas going beyond this, which would have to be used for an expansion to 40 GW, only a reservation is specified in the draft maritime spatial plan, in order to be able to examine these in more detail in the context of a later update of the FEP, if necessary, and to define them as concrete areas, insofar as the environmental assessment supports this.

Designating the areas now planned as reserved areas for wind energy as priority areas is not seriously considered, as this would not be compatible with the competence of spatial planning:

a) spatial planning is a medium-term planning and in this time horizon a development with wind energy parks in the areas designated as reserved areas is not necessary;

b) a final balance is not possible due to the uncertainty regarding developments in the EEZ beyond 2035.

Alternative 1: Wind energy	
Brief description	• Areas for wind energy that are not required for the legally stipulated 20 GW of installed capacity, but only for expansion beyond this, are designated as reserved areas for wind energy.
Presentation of the alternative in comparison to the draft plan	• In the draft plan, all areas likely to be required for the medium-term expansion of wind energy up to 2035 are identified as priority areas (EN1 to EN3, EN6 to EN13), all other areas (E4, 5 and 14 to 19) as reserved areas.

Consequence / consequences for next planning levels	• The FEP2020 does not yet define any areas for the EN11 to EN13 areas. The preliminary investigation and suitability test will only be carried out for the areas defined in the FEP. Thus, the designation as reserved areas does not have any direct consequences at the downstream level for the time being, although further designations in the course of an update of the RDP for wind energy development up to 2025 could not refer to the priority areas in the maritime spatial plan. A partial update of the ROP could then become necessary for these areas.
Environmental assessment	• The designation of EN11 to EN13 as reserved areas leaves the safeguarding of offshore wind energy open to the extent that no final consideration has been made in favour of this use. This means that more extensive environmental assessments will be required at a later date, for which it will probably be possible to draw on findings already available from the procedures in areas EN9 and EN10. • However, based on the above-mentioned results of this SEA and the SEA for the FEP, the data and knowledge base is already sufficient to define areas EN11 to EN13 as priority areas for wind energy.
Alternative 2: Wind energy	
Brief description	• The areas of the wind farms located in the main distribution area of the common diver in areas EN4 and EN5 are not designated as reserved areas for wind energy.
Presentation of the alternative in comparison to the draft plan	• Thus, in the long term, no areas for wind energy within the reserved area for divers would be permissible for subsequent use of the existing wind farms if, at the same time, the construction of turbines outside the areas designated for this purpose is excluded.
Points of conflict with other uses	• This solution would presumably - even if all other areas identified in the draft plan were used - result in insufficient areas being available in the German EEZ to achieve the long-term expansion target for wind energy of 40 GW.
Consequence / consequences for next planning levels	• In areas EN4 and EN5, once the operating permits for the existing and approved wind farms have expired and the turbines have been dismantled, no further permission would be granted for repowering.
Environmental assessment	• With regard to the environmental impacts, the observed avoidance effects and habitat losses of the common diver could be mitigated or compensated in the long term by the wind farm projects implemented in the main concentration area - following planning option C.

9.3.2.3 Lines

The reserved areas for pipelines correspond to those already shown in the concept in all three planning options. Only corridors in which at least two lines exist or are planned, or which are reserved for future lines, have been identified. These are required for the cable systems for diverting electricity from the areas for offshore wind energy generation, based on the specifications of the area development plan. The reserved areas safeguard the course of existing interconnectors and pipelines, as well as routes for future cables and pipelines.

In the designations, nature conservation areas are excluded as far as possible, with the following exceptions:

- the routes of the existing pipelines crossing the Dogger Bank nature reserve,
- the route for the existing and planned connection lines in the direction of the Ems corridor through the Borkum Riffgrund NSG.

By not specifying corridors for individual lines, some existing or projected cable routes through the nature conservation areas are not specified.

Compared to the planning concept, border corridors at the transition of the transmission lines into the coastal sea have been added, similar to the specifications of the ROP 2009 and based on the specifications of the FEP.

The reserved areas for pipelines can be an instrument, for example in approval procedures for transit pipelines and cross-border submarine cables, to demand routing, where possible, in these corridors that are suitable for the whole area, and thus to avoid routing through nature conservation areas and the associated impairments. Where individual cables or other pipelines are currently routed through nature conservation areas, it is not possible to refer to a reservation from spatial planning in the case of changes or new project planning, but if necessary to work towards a more nature-compatible routing and, where possible, the use of the defined corridors.

Alternative: Lines	
Brief description	• Pipeline corridors for cable systems for the discharge of wind energy generated in the EEZ are not routed through nature conservation areas, but around them.
Presentation of the alternative in comparison to the draft plan	• This alternative would mean that the pipeline corridor, which in the draft plan runs through the Borkum Riffgrund NSG, would either not be shown or would have to be routed around the protected area altogether.
Points of conflict with other uses	• There would be a conflict here with the sectoral planning and the Lower Saxony regional planning for the coastal sea, and with the cable systems that already exist here and those that would be required to divert energy generated in the EEZ towards the Ems corridor.
Consequence / consequences for next planning levels	• Future cable systems would have to be routed primarily in a corridor around the Borkum Riffgrund NSG. This would mean that the cable would be routed in the direction of the border corridor through which the Norpipe pipeline runs, and from there it would have to be routed back to the Ems corridor in the territorial sea. However, there is no spatial planning option for this in the territorial sea.
Environmental assessment	• With a - future - bypassing of cable routes around the nature conservation area, this area would be less burdened, but - apart from the lack of a planning basis - additional burdens would have to be expected both in the EEZ and in the area of the territorial sea due to the new routing and significant additional lengths of the cables.

9.3.2.4 Raw material extraction

For the specifications for raw material extraction in the North Sea EEZ, the draft includes - in addition to the assumptions on which all planning options are based - the approach of planning option A:

Reserved areas for the extraction of hydrocarbons as well as for sand and gravel extraction are defined in accordance with planning option A, whereby an additional area was included between the priority areas for wind energy EN1 and EN2. The NSG Riffgrund was excluded from the area allocation.

The area of the A6/B4 gas production platform at the outermost edge of the Duck's Bill - in contrast to the three planning options - is also only defined as a reserved area for raw material extraction and no longer as a priority area due to the fact that gas production has already ceased and the current use of the platform for oil processing from Danish production is likely to end.

There are large-scale licences for the exploration and production of gas in the south-western part of the EEZ and knowledge about deposits worth producing. The licences also cover the area of the Borkum Riffgrund NSG. If, as in planning options B and C, no reserved areas for extraction are defined, it is not possible for spatial planning to refer to the principle preferring a specific sub-area for this purpose in the context of licensing procedures under mining law, and thus to refer to sites for stationary exploration or extraction equipment outside the protected area. Even if raw material extraction is not fundamentally ruled out in the nature conservation area, the fact that the maritime spatial plan does not specify hydrocarbons within the conservation area means that this use is given less weight and thus helps to avoid possible significant effects on the conservation area and its conservation purposes.

In the overlap area with reserved areas for offshore wind energy, synergy effects could be used in terms of land-efficient use for fixed infrastructure. KWN4 and 5 are located in the area of the shipping routes SN3 and SN12. Preference should be given to sites for fixed infrastructure in the less frequented peripheral areas, possibly in close proximity to existing or planned neighbouring wind farm projects.

The permit areas for sand and gravel extraction within the Sylt Outer Reef National Park are designated as reserved areas analogous to planning options A and B. Here, the interaction with the designations of the priority area divers and the priority area nature conservation must be taken into account. The principle of avoiding extraction from 1 March to 15 May is intended to protect the divers, for which the area has an important function as a resting area during this period.

The alternative of not designating any areas, as envisaged in planning option C, would probably not de facto reduce environmental impacts, since sand and gravel extraction is generally permitted as a privileged use in the nature conservation area and, if approved, is subject to corresponding conditions to mitigate and avoid impairments of the protected goods and objectives.

Alternative: Raw material extraction	
Brief description	• The hydrocarbon exploration permits issued by the Mining Authority are entirely designated as reserved areas for the extraction of hydrocarbons (gas).
Presentation of the alternative in comparison to the draft plan	• Only individual sub-areas are included in the draft plan as reserved areas for raw material extraction. Overlaps with the Borkum Riffgrund National Park are avoided, but there are spatial overlaps with areas for wind energy, shipping routes and transmission line corridors.
Points of conflict with other uses	• The licence areas coincide with various uses and functions affected in different ways, with the Borkum Riffgrund NSG, main shipping routes, pipeline corridors.
Consequence / consequences for next planning levels	• Spatial planning could not work towards preferred locations for fixed infrastructure for the exploration or production of hydrocarbons that are less conflictive with regard to other use and protection interests.
Environmental assessment	• The designation of a reserved area for the extraction of hydrocarbons, particularly in the nature conservation area, would give this use additional weight within the framework of spatial planning, despite the possible negative effects, including through fixed infrastructure. In this respect, the draft plan's decision not to designate hydrocarbons within the conservation

	area helps to avoid possible significant effects on the conservation area and its conservation purposes.

9.3.2.5 Fishing

Compared to the conception, which did not yet contain any spatial specifications, a new reserved area for fishing for Norway lobster (*Nephrops Norvegicus*) is defined for fisheries.

Unlike for other target species and fisheries, the occurrence and fishing effort for Norway lobster in the German EEZ can be relatively well determined and delimitedROP . The reserved area traces the current use and roughly covers the core area of fishing effort. Spatial management of Norway lobster fisheries cannot be brought about by the maritime spatial plan. By designating the reserved area, fishing can be given special weight here vis-à-vis competing uses.

Alternative designations for fisheries were considered, but due to a lack of current data on spatial allocation, no further areas could be designated for spatial planning purposes.

9.3.2.6 Protection and enhancement of the marine environment

With the spatial designations for the protection and improvement of the marine environment in the EEZ of the North Sea, the nature conservation areas Sylter Außenriff - Östliche Deutsche Bucht, Borkum Riffgrund and Doggerbank, which have been designated by ordinance, are also safeguarded in spatial planning and their protection purposes are supported. In addition, the designation of further areas with a special ecological function also supports MSFD environmental objective 3 "Seas not adversely affected by the impact of human activities on marine species and habitats": the main concentration area of divers[12] as a priority area and the main distribution area of the harbour porpoise[13] as a reserved area, the latter being restricted to the months of May to August, which are particularly sensitive for the species. Thus, the planning approach from planning option C of the conception is taken up for the nature conservation areas, whereby the main concentration area of the common diver was defined as a priority area in the draft plan.

Sand and gravel extraction continues to be permitted in the Sylt Outer Reef, but the designation as a nature conservation priority area also in the area of the SKN 1 and SKN2 areas can support the consideration of the interests to be protected in the case of approvals and permits in addition to the requirements of the nature conservation area ordinances.

The priority area for common divers also includes the existing wind farms in areas EN4 and EN5. This supports a special consideration here for a possible subsequent use of the areas, to what extent additional impairments of the habitat and significant cumulative impacts on the population of divers are to be worried about, and the sites may have to be reassessed. In the land development plan, these sites are also shown as being under consideration.

Area EN13 partly overlaps with the reserved area for harbour porpoises. In future procedures for the construction of wind turbines, requirements for suitable and effective measures to avoid and reduce impulsive noise emissions should be supported (cf. Chap. 10). This should be ensured in particular during the sensitive period for harbour porpoises in order to provide the

[12] Position paper of the division of the Federal Ministry for the Environment on the cumulative assessment of loon habitat loss due to offshore wind farms (2009)

[13] Noise protection concept of the Federal Environment Ministry (2013)

animals with sufficient high-quality habitats at all times.

9.4 Justification for the choice of alternatives examined

The alternatives assessment at the spatial planning level compares conceptual/strategic planning options and spatial alternatives in the plan design.

The alternatives assessment took place in parallel with the preparation of the plan, and a preliminary assessment of possible and conceivable planning options is already inherent in all specifications in the form of objectives and principles. As can be seen from the justification of the individual objectives and principles, especially those with environmental relevance, the respective determination is already based on a consideration of possible affected public concerns and legal positions, so that a "preliminary examination" of planning options or alternatives has already taken place.

When selecting the alternatives examined, the objectives and the spatial scope of the maritime spatial plan were always taken into account. At the same time, it applied to the identification and examination of the planning options or plan alternatives under consideration that these can only relate to what can reasonably be required according to the content and level of detail of the maritime spatial plan.

Alternative spatial determinations have been considered for almost every use, whereby other locations are not always possible or sensible in the limited dimensions of the EEZ. For example, the extraction of raw materials is bound to fixed locations and shipping also requires spatial designations on the main traffic routes. Likewise, the priority areas for nature conservation trace the protected areas and thus the occurrence of protected species or biotopes.

For each use, it was therefore examined whether an alternative design was possible via textual specifications, especially if spatial alternatives could not be considered as reasonable alternatives. In this way, the type of use in the areas could be specified in such a way that the extent of the impact is reduced. This environmental precaution applies to shipping as well as to economic and scientific uses. These include the seasonal limitation of activities to protect sensitive bird species and marine mammals or the reference to mitigation measures and best environmental practice.

Since the spatial definition in many cases only traces the use and had little design scope for locating the use at this point, the search for alternative design and consideration for the marine environment was an essential step in the alternatives assessment. In this way, conflicts between protection needs and use claims are mitigated and improved in terms of environmental compatibility.

10 Planned measures for monitoring the effects of the implementation of the maritime spatial plan on the environment

10.1 Introduction

According to No. 3 b) Annex 1 to sec. 8 para. 1 ROG, the environmental report also contains a description of the planned monitoring measures. Monitoring is necessary, in particular, to identify unforeseen significant impacts at an early stage and to be able to take appropriate remedial action.

With regard to the planned monitoring measures, it should be noted that the actual monitoring of potential impacts on the marine environment can only begin at the moment when the maritime spatial plan is implemented, i.e. the specifications made within the framework of the plan are realised. Nevertheless, the natural development of the marine environment, including climate change, must not be disregarded when assessing the results of monitoring measures. However, general research cannot be carried out within the framework of monitoring. Therefore, project-related monitoring of the impacts of the uses regulated in the plan is of particular importance. This mainly concerns specifications for offshore wind energy, pipelines and areas for raw material extraction.

The essential task of monitoring the Plan is to bring together and assess the results from different phases of monitoring at the level of individual projects or clusters of projects developed in a spatial and temporal context. The assessment will also cover the unforeseen significant effects of the implementation of the Plan on the marine environment as well as the review of the projections of the environmental report.

In addition - also to avoid duplication of work - results from existing national and international monitoring programmes are to be taken into account. The monitoring of the conservation status of certain species and habitats required under Article 11 of the Habitats Directive should also be included, as well as the investigations to be carried out in the course of the management plans for the nature conservation areas "Sylter Außenriff - Östliche Deutsche Bucht", "Borkum Riffgrund" and "Doggerbank". There will also be links to the measures envisaged in the MSFD.

10.2 Planned measures in detail

In summary, the planned measures for monitoring the potential impacts of the Plan are as follows:

- Bringing together data and information that can be used for describing and assessing the status of areas, protected assets,
- Development of expert information networks for assessing the potential impacts from the development of individual projects as well as the cumulative impacts on the marine ecosystem,
    - MarinEARS (Marine Explorer and Registry of Sound) and National Sound Registry,
    - MARLIN (Marine Life Investigator),
- Develop appropriate procedures and criteria for evaluating the results of effect monitoring of individual projects,
- Development of procedures and criteria for the assessment of cumulative effects,
- Develop procedures and criteria for forecasting potential impacts of the plan in spatial and temporal context,
- Develop procedures and criteria for the evaluation of the plan and adapt or optimise as necessary in the context of the update,

- Evaluation of measures to avoid and reduce significant impacts on the marine environment,
- Development of norms and standards.

The following data and information are required for the assessment of the potential effects of the plan:

1. Data and information available to the BSH within the scope of its competence:
   - Data sets from previous EIAs and monitoring of offshore projects that are available to the BSH for review (according to SeeAnlV),
   - Data files from the right of entry (according to WindSeeG),
   - Data sets from the preliminary investigations (according to WindSeeG),
   - Data sets from construction and operation monitoring of offshore wind farms and other uses
   - Data from national monitoring collected by or on behalf of the BSH,
   - Data from BSH research projects.
2. Data and information from the areas of responsibility of other federal and state authorities (on request):
   - Data from the national monitoring of the North Sea and Baltic Sea (formerly BLMP),
   - Data from monitoring measures within the framework of the implementation of the MSFD,
   - Data from the monitoring of Natura 2000 sites,
   - Country data from monitoring in the territorial sea,
   - Data from other authorities responsible for permitting uses at sea under other legal bases, e.g. under BBergG, maritime traffic monitoring (AIS), fisheries monitoring (VMS).
3. Data and information from federal and state research projects, including:
   - HELBIRD / DIVER,
   - Sediment EEZ
4. Data and information from assessments within the framework of international bodies and conventions:
   - OSPAR
   - ASCOBANS
   - AEWA
   - BirdLife International

For reasons of practicability and the appropriate implementation of requirements from the strategic environmental assessment, the BSH will pursue an ecosystem-oriented approach as far as possible when monitoring the possible impacts of the plan, which focuses on the interdisciplinary pooling of marine environmental information. In order to be able to assess the causes of plan-related changes in parts or individual elements of an ecosystem, anthropogenic variables from spatial monitoring (e.g. specialist information on shipping traffic from the AIS datasets) must also be considered and included in the assessment.

When combining and evaluating the results from monitoring at project level and from other national and international monitoring programmes, as well as from the accompanying research, it will be necessary to review the gaps in knowledge or the forecasts with uncertainties presented in the environmental report. This applies in particular to forecasts concerning the assessment of significant impacts of the uses regulated in the maritime spatial plan on the marine environment. Cumulative effects of defined uses should be assessed both regionally and supraregionally.

The investigation of potential environmental impacts of areas for wind energy has to be carried out at the downstream project level following the standard "Investigation of impacts of offshore wind turbines (StUK4)" and in coordination with the BSH. Monitoring during the construction of foundations by means of pile driving includes, among other things, measurements of underwater sound and acoustic recordings of the effects of pile driving on marine mammals using POD measuring devices. The data are quality-checked and processed in the BSH's specialist information system for underwater sound MarinEARS. Information and evaluations are made available via the MarinEARS web portal (https://marinears.bsh.de/FIS_SCHALL_PORTAL/pages/index.jsf).

With regard to the specific measures for monitoring the potential impacts of wind energy use, including impacts from power cables, reference is made to the detailed explanations in the Environmental Report on the FEP 2019/ Draft FEP 2020.

For the approval of areas for sand and gravel extraction, for example, it must be demonstrated by suitable monitoring that the maximum permitted extraction depth is not exceeded and that the original substrate is demonstrably preserved before the next main operating plan approval. Furthermore, it must be demonstrated that sufficient unmined areas remain between the excavation tracks so that the recolonisation potential is given.

For pipelines, a project-specific monitoring concept for the construction and operational phases must be submitted prior to construction. Monitoring measures during the construction phase include the documentation of turbidity plumes, hydro-sound measurements and the recording of marine mammals and seabirds and resting birds. Essential monitoring measures during the operational phase of pipelines include annual documentation of the positional stability of the pipeline and the cover heights as well as annual documentation of the epifauna on the overlying pipeline for a period of five years after commissioning.

The strategic environmental assessment for the plan will use new findings from the environmental impact studies and from the joint evaluation of research and EIS data. A joint evaluation of the research and EIS data will also produce products that provide a better overview of the distribution of biological protected assets in the EEZ. The pooling of information leads to an increasingly solid basis for impact prediction.

In general, the intention is to keep data from research, projects and monitoring uniform and to make it available in a competently evaluated form. In particular, the creation of joint overview products for reviewing impacts of the plan is to be aimed for here. The geodata infrastructure already available at the BSH with data from physics, chemistry, geology and biology as well as uses of the sea will be used as a basis for the consolidation and evaluation of ecologically relevant data and will be further developed accordingly.

With regard to the consolidation and archiving of ecologically relevant data from project-related monitoring and accompanying research, it is planned in detail to also consolidate and archive in the long term data collected in the course of accompanying ecological research at the BSH. The data on biological assets from the baseline surveys of offshore wind energy projects and from the monitoring of the construction and operation phases are already collected and archived at the BSH in a specialist information network for environmental assessments known as MARLIN (MarineLife Investigator).

11 Non-technical summary

11.1 Subject and occasion

Maritime spatial planning in the German Exclusive Economic Zone (EEZ) is the responsibility of the federal government under the Spatial Planning Act (ROG)[14]. Pursuant to sec. 17 para. 1 ROG, the competent Federal Ministry, the Federal Ministry of the Interior, for Building and the Home Affairs (BMI), draws up a spatial plan for the German EEZ as a statutory instrument in agreement with the Federal Ministries concerned. Pursuant to sec. 17 para. 1 sentence 3 of the ROG, the BSH, with the approval of the BMI, carries out the preparatory procedural steps for the preparation of the maritime spatial plan. During the preparation of the ROP, an environmental assessment is carried out in accordance with the provisions of the ROG and, where applicable, those of the Environmental Impact Assessment Act (UVPG)[15], the so-called Strategic Environmental Assessment (SEA).

According to Art. 1 of the SEA Directive 2001/42/EC, the aim of SEA is to ensure a high level of environmental protection in order to promote sustainable development and to help ensure that environmental considerations are adequately taken into account in the preparation and adoption of plans well before the actual planning of the project.

The main content document of the Strategic Environmental Assessment is this Environmental Report. This identifies, describes and assesses the likely significant effects that the implementation of the ROP will have on the environment, as well as possible and alternative planning options, taking into account the main purposes of the plan and the spatial scope.

According to sec. 17 para. 1 ROG, the maritime spatial plan for the German EEZ shall, taking into account any interactions between land and sea as well as taking into account safety aspects, determine

1. to ensure the safety and ease of shipping traffic,
2. to other economic uses,
3. scientific uses and
4. to protect and enhance the marine environment.

Pursuant to sec. 7 para. 1 of the ROG, maritime spatial plans must define **objectives and principles of** spatial planning for the development, organisation and protection of the area, in particular the uses and functions of the area, for a specific planning area and for a regular medium-term period.

Pursuant to sec. 7 para. 3 ROG, these designations may also designate areas, such as priority and reserved areas.

For the area of the German EEZ, a multi-stage planning and approval process is envisaged for some uses, such as offshore wind energy and power cables. The instrument of maritime spatial planning is at the highest and superordinate level in this context. The maritime spatial plan is the forward-looking planning instrument that coordinates the most diverse utilisation interests of the economy, science and research as well as protection claims. The SEA for the maritime spatial plan is related to various downstream environmental assessments, in particular the directly downstream SEA for the land development plan (FEP).

[14] Of 22 December 2008 (Federal Law Gazette I p. 2986), last amended by Article 159 of the Ordinance of 19 June 2020 (Federal Law Gazette I p. 1328).

[15] In the version published on 24 February 2010, Federal Law Gazette I p. 94, last amended by Article 2 of the Act of 30 November 2016 (Federal Law Gazette I p. 2749).

The FEP is the technical plan for the orderly expansion of offshore wind energy. In the next step, the areas defined in the FEP for offshore wind turbines are pre-screened. If the suitability of an area for the use of offshore wind energy is determined, the area is put out to tender and the winning bidder can submit an application for permission to erect and operate wind turbines on the area. In view of the character of the maritime spatial plan as a controlling planning instrument, the depth of the assessment of likely significant environmental impacts is characterised by a greater breadth of investigation and, in principle, a lesser depth of investigation. The focus of the assessment is on the evaluation of cumulative effects and the examination of alternatives.

The preparation or updating of the maritime spatial plan and the implementation of the SEA are carried out taking into account environmental protection objectives. These provide information on the environmental status to be aimed for in the future (environmental quality objectives). The environmental protection objectives can be derived from an overall view of the international, Community and national conventions and regulations that deal with marine environmental protection and on the basis of which the Federal Republic of Germany has committed itself to certain principles and objectives.

11.2 Methodology of the Strategic Environmental Assessment

The present environmental report builds on the existing methodology of the SEA of the land development plan and develops it further with a view to the additional specifications made in the maritime spatial plan.

The methodology depends primarily on the provisions of the plan to be assessed. Within the framework of this SEA, it is determined, described and assessed for the individual specifications whether the specifications are likely to have significant effects on the objects of protection concerned. The subject of the environmental report corresponds to the provisions of the maritime spatial plan as listed in Article 17(1) ROG. The effects of the spatial specifications are particularly relevant here. Although textual objectives and principles without direct spatial definition often also serve to avoid and reduce environmental impacts, they can in turn also lead to impacts, so that an assessment is required.

The assessment of the likely significant environmental effects of the implementation of the maritime spatial plan includes secondary, cumulative, synergetic, short-, medium- and long-term, permanent and temporary, positive and negative effects in relation to the protected assets. The basis for the assessment of possible impacts is a detailed description and assessment of the state of the environment. The SEA has been carried out with regard to the following protected interests:

- Area
- Floor
- Water
- Plankton
- Biotope types
- Benthos
- Fish
- Marine mammals
- Avifauna
- Bats
- Biodiversity
- Air
- Climate
- Landscape
- Cultural assets and other material assets
- People, especially human health
- Interactions between protected goods

The description and assessment of the likely significant environmental impacts is carried out for the individual specifications in the drawings and texts on the use and protection of the EEZ in relation to the protected species, taking into account the assessment of the status quo.

All plan contents that can potentially have significant environmental impacts are examined. Both permanent and temporary, e.g. construction-related, effects are considered. This is followed by a presentation of possible interactions, a consideration of possible cumulative effects and potential transboundary impacts.

An assessment of the effects of the provisions of the plan is carried out on the basis of the description and assessment of the status and the function and significance of the respective designated areas for the individual objects of protection on the one hand and the effects and resulting potential effects of these provisions on the other. A forecast of the project-related effects during implementation of the maritime spatial plan is made depending on the criteria of intensity, scope and duration of the effects.

Within the framework of the impact forecast, specific framework parameters are used as a basis for assessment, depending on the specifications for the respective use.

With regard to the priority and reserved areas for offshore wind energy, certain parameters in the form of bandwidths are assumed for a consideration of the protected goods. In detail, these include power per turbine, hub height, rotor diameter and total height of the turbines. Certain framework parameters are also assumed for pipelines, sand and gravel extraction, fisheries and marine research. For the assessment of the environmental impacts caused by shipping, it is necessary to investigate which additional impacts can be attributed to the stipulations in the maritime spatial plan. The BSH has commissioned an expert opinion on the analysis of shipping traffic, for which up-to-date evaluations are expected.

11.3 Summary of the tests related to the protected goods

11.3.1 Area

The German EEZ in the North Sea and Baltic Sea is of great importance for many uses and for the marine environment. At the same time, its area is limited, so land-saving use is imperative. Sparing use of land is therefore also reflected in the guidelines and principles of the maritime spatial plan.

The basis for sustainable development of the limited resource of land in the EEZ of the North Sea and Baltic Sea is the most efficient and sparing use of land, especially in the case of competing uses. This can lead to a situation where the ROP does not always define the desirable area for uses, but the sufficient area.

Another aspect of sustainable and economical use of land resources is the obligation to dismantle structures, submarine cables, etc. after the end of their operating life, so that these areas are available for subsequent use.

Due to the following points, an assessment of the extent to which the provisions of the ROP have an impact on the protected resource land is only possible in a synopsis of all uses:

- Temporally and spatially overlapping uses possible
- Mostly no 100% permanent land consumption of a use
- Not all uses actually consume land in the sense of seabed.

This summary consideration with regard to the protected resource of land was carried out within the framework of the specifications for the individual uses in the ROP itself.

11.3.2 Floor

Sedimentology and morphology of the seabed in the German EEZ of the North Sea show regional differences, which can be well delineated by dividing them into four sub-areas (see also Chapter 2.2.2):

In the sub-area "Borkum and Norderney Reef Ground" (water depth: 18 to 42 m), the sediments are predominantly medium to coarse sand, which show ripple fields and are occasionally interspersed with gravel and head-sized stones. Morphologically significant are the outcrops of tongue reefs at the southern edge of the sub-basin, which run in a northwest-southeast direction and are subject to pronounced sediment dynamics.

The sub-area "North of Heligoland" (water depth: 9 to 50 m) is characterised by a very uneven relief for the conditions in the German Bight. Ice-age ridges have the characteristic covering of residual or relict sediments (coarse sands, gravels and stones). Between these residual sediment deposits, fine to medium sands of low thickness occur, which are subject to constant rearrangement. Compared to the other sub-basins, a high density of stones can be observed on the seabed.

The seabed of the sub-area "Elbe-Urstromtal and western plains" (water depth: 30 to 50 m) has a very balanced relief and is largely flat. It consists of fine sands with partly distinct contents of silt and clay. The dominant element in the subsoil is the Elbe glacial valley at the eastern edge of the sub-basin. This valley, which used to be about 30 km wide, is filled with an alternating layer of sandy and silty-clay sediments.

The area of the so-called "Duck's Bill" comprises the sub-area "Dogger and Northern Shill Bank". The north-eastern spur of the Dogger Bank - a submarine ridge - crosses this area. The seabed, which is relatively poor in structure, consists mainly of a fine sand cover with appreciable silt and clay content. The seabed as a protected resource is primarily affected by offshore wind energy, raw material extraction, pipelines and fishing.

With the installation of wind turbines, platforms, submarine cable systems and pipelines (incl. scour protection), permanent but very small-scale surface sealing occurs. The impacts during construction activities mainly include the formation of turbidity plumes and sedimentation of the resuspended material, which can also be classified as small-scale.

In the course of sand and gravel extraction, the seabed is mainly affected by the removal of substrate, a change in the bottom topography and the sedimentation of suspended material. However, the current extraction activities in the OAM-III permit area do not appear to have any significant adverse effects on the legally protected biotopes and soil.

Seabed levelling can also be observed with intensive fishing, as well as near-bottom turbidity plume formation.

With the exception of two points (see below), the above-mentioned impacts are independent of the ROP and no significant negative impacts on soil are to be expected. On the contrary, adverse impacts can be avoided by the spatially coordinating specifications of the ROP and by the specifications on the best environmental practice to be applied in each case.

With regard to wind energy, the ROP stipulations are associated with an expansion of the area of use, and the spatial stipulations in the ROP also assign a longer-term space requirement to the extraction of raw materials. In both cases, no significant impacts on the seabed are to be expected given the current state of technology/extraction practice.

11.3.3 Benthos and biotopes

The North Sea EEZ is not of outstanding importance with regard to the species inventory of benthic organisms. The identified benthic communities also have no special features, as they are typical for the North Sea EEZ due to the prevailing sediments. Investigations of the macrozoobenthos in the context of the approval procedures for offshore wind farms and from AWI projects from the years 1997 to 2014 have revealed communities typical for the German North Sea. The species inventory found and the number of Red List species indicate an average importance of the study area for benthic organisms.

The deep foundations of the wind turbines and platforms cause disturbance of the seabed, sediment resuspension and the formation of turbidity plumes. The resuspension of sediment and the subsequent sedimentation can lead to impairment or damage to the benthos and the use of biotopes in the immediate vicinity of the foundations for the duration of the construction activities. However, due to the prevailing sediment characteristics, these impairments will only have a small-scale effect and are narrowly limited in time. As a rule, the concentration of suspended material decreases very quickly with distance. Changes in the species composition may occur in the immediate vicinity of the structures due to the local sealing of surfaces and the introduction of hard substrates.

The laying of the submarine cable systems is also expected to cause only small-scale and short-term disturbances to the benthos and biotopes due to sediment turbulence and turbidity plumes in the area of the cable route. Possible impacts on benthos and biotopes depend on the installation methods used. Only minor disturbances in the area of the cable route are to be expected with the comparatively gentle installation using the flushing-in method. For the duration of the laying of the submarine cable systems, local sediment shifting and turbidity plumes are to be expected. Due to the prevailing sediment characteristics in the North Sea EEZ, most of the released sediment will settle directly at the construction site or in its immediate vicinity. In the area of required riprap for cable crossings, benthic habitats will be directly overbuilt. The resulting habitat loss is permanent but small-scale. An off-site hard substrate is created, which can cause small-scale changes in species composition.

Permanent habitat alterations are limited to the immediate area of the foundations and riprap required in the case of seabed cable laying and cable crossings. The rock fills permanently represent an off-site hard substrate. This provides new habitat for benthic organisms and can lead to a change in species composition. Significant impacts by these small-scale areas on benthos and biotopes are not to be expected. In addition, the risk of a negative impact on the benthic soft-bottom community by species untypical of the area is low, as the recruitment of species will most likely occur from the natural hard substrate habitats.

Operationally, heating of the uppermost sediment layer of the seabed may occur directly above the cable system. With sufficient installation depth and taking into account the fact that the effects will occur on a small scale, no significant impacts on the benthic communities are expected according to current knowledge. The ROP establishes a planning principle to minimise adverse effects as far as possible; special consideration is to be given to marine environmental protection concerns when selecting the cover and the necessary laying depth of power and data cables. ROP

At the level of sectoral planning (FEP), the planning principle on sediment warming specifies that the 2 K criterion must be complied with. According to the BfN's current assessment, this precautionary value ensures with sufficient probability that significant negative impacts of cable heating on the marine environment are avoided. According to the current state of knowledge, the planned submarine cable routes are not expected to have any significant impacts on benthos and biotopes if the 2C criterion is met. The ecological impacts are small-scale and mostly short-term.

With regard to the stipulations on the use of raw materials, the long-term monitoring of the gravel sand deposit area "OAM III" in the area of the nature reserve "Sylt Outer Reef - Eastern German Bight" currently provides no indications that the previous extraction activities have led to a fundamental change in the sediment structure or composition in the extraction area. Overall, the investigations show that the original substrate in the area could be preserved and that there is a regenerative capacity, especially for species-rich gravel, coarse sand and shingle beds. On the basis of the monitoring carried out so far and in compliance with the incidental provision of the main operating plan, it can therefore be assumed that significant impairments of benthic habitats and their communities can be ruled out with the necessary certainty as a result of the determination on the use of raw materials.

For decades, the planned reserved area for Norway lobster fishing has been considered the traditional main catch area for *Nephrops norvegicus*, with catches of between approx. 200 and 350 t per year. Increases in fishing effort due to the designation as a reserved area are not predicted. Thus, significant impacts on benthic communities and biotopes can be ruled out on the basis of the ROP provisions on fisheries. With regard to the general designation for aquaculture, the fulfilment of conditions for the exclusion of possible significant adverse effects on the marine environment must be examined in downstream plans or at project level.

With regard to the uses of shipping, marine research, national and allied defence and other uses, no significant effects on benthos and biotopes are to be expected due to the specifications of the ROP, which would go beyond the general effects of the uses without specification.

The designation of designated nature conservation areas in the North Sea EEZ as Priority Nature Conservation Areas supports the positive effects on benthic communities and biotopes that can be expected on the basis of appropriate management measures of the nature conservation areas.

11.3.4 Fish

The fish fauna shows a typical species composition in the area of the North Sea EEZ. In all areas, the demersal fish community is dominated by flatfish, which is typical for the German Bight. According to current knowledge, the priority areas for wind energy do not represent a preferred habitat for any of the protected fish species. Consequently, according to current knowledge, the fish population in the planning area is not of outstanding ecological importance compared to adjacent marine areas. According to the current state of knowledge, the planned construction of wind farms and the associated converter platforms and submarine cable routes are not expected to have a significant adverse effect on fish. The impacts of the construction of the wind farms, converter platforms and submarine cable systems on fish fauna are spatially and temporally limited. During the construction phase of the foundations, the converter platforms and the laying of the submarine cable systems, sediment turbulence and the formation of turbidity plumes may have a small-scale and temporary impact on fish fauna. Due to the prevailing sediment and current conditions, the turbidity of the water is expected to decrease again quickly. Thus, according to the current state of knowledge, the impairments will remain small-scale and temporary. Overall, small-scale impairments can be assumed for adult fish. In addition, the fish fauna is adapted to the natural sediment turbulence caused by storms. Furthermore, during the construction phase, noise and vibrations may temporarily displace fish. Noise from the construction phase must be mitigated by appropriate measures. Further local impacts on fish fauna may result from the additionally introduced hard substrates due to a possible change in the benthos.

According to current knowledge, the designation of the nature conservation priority areas can have a significant positive impact on fish fauna and counteract the overexploitation of some fish stocks in the North Sea.

The designation of other uses in the maritime spatial plan, such as raw material extraction, shipping, national and alliance defence or nephrops fishing, does not result in any significant impacts on fish fauna that would exceed the general impacts of uses without designation, according to the information available to date.

With regard to the general definition of aquaculture, the fulfilment of conditions for the exclusion of possible significant adverse effects on the marine environment must be examined in downstream plans or at project level.

11.3.5 Marine mammals

According to the current state of knowledge, it can be assumed that the German EEZ is used by harbour porpoises for transiting, staying and also as a feeding area and, depending on the area, as a nursery area. Based on the available knowledge, the EEZ is of medium to high importance for harbour porpoises in some areas. Use varies in the different parts of the EEZ. This also applies to harbour seals and grey seals. Priority areas EN1 to EN3 are of medium to - seasonally in spring - high importance for harbour porpoises, and of low to medium importance for grey seals and harbour seals. Priority area EN4 is located in the identified main concentration area of harbour porpoise in the German Bight in the summer months and is therefore of high importance. For harbour seals and grey seals, priority area EN4 has medium importance. Priority area EN5 is located in a large area used both as a feeding and breeding area for harbour porpoises - even though the main concentration is within Area I of the nature reserve "Sylt Outer Reef - Eastern German Bight". In general, it can be assumed that priority area EN5 is of high importance for harbour porpoises. For harbour seals and grey seals, area EN5 is of medium importance. Priority areas EN6 to EN12 are of medium importance for harbour porpoises. However, parts of priority area EN11 and priority area N13 are intensively used by harbour porpoises as feeding grounds in summer. They are located in the immediate vicinity of the coherent main concentration area of harbour porpoise in the German Bight and are therefore of high importance for harbour porpoises in the summer months. For harbour seals and grey seals, priority areas EN6 to EN13 are of low importance. Reserved areas EN14 to EN18 are of medium importance for harbour porpoises, and of low importance for harbour seals and grey seals. Reserved area EN19 is of medium importance for harbour porpoises and of high seasonal importance in the summer months. In contrast, it is of low importance for harbour seals and grey seals.

The plan identifies three areas as priority areas for nature conservation: "Sylt Outer Reef - Eastern German Bight", "Borkum Riffgrund" and "Dogger Bank". In addition, the plan designates the main concentration area in the German EEZ identified in the BMU's noise protection concept (2013) as a reserved area for the protection of harbour porpoises during the breeding season from 1 May to 31 August.

The ROP identifies areas for wind energy production outside the nature conservation areas. The ROP thus ensures that direct impacts from the construction and operation of offshore wind farms within nature conservation areas are excluded.

The ROP also provides for the designation of a reserved area for harbour porpoises in the German EEZ of the North Sea. The reserved area represents the main concentration area of the harbour porpoise during the sensitive period from 1 May to 31 August, which was identified as part of the development of the BMU noise protection concept (2013). The seasonal reserved area of the harbour porpoise comprises Area I of the nature conservation area "Sylt Outer Reef - Eastern German Bight" and its surroundings. In physical terms, the reserved area thus generously encompasses the area of the frontal system west of the North Frisian Islands. Due to weather and currents, the frontal system spreads very dynamically into the reserved area and ensures increased productivity and rich food supply for TOP predators, such as harbour porpoise and many seabird species. By designating the seasonal reserved area, the maritime spatial plan takes a preventive measure to secure the food-rich alternative habitat of the harbour porpoise outside Area I of the nature reserve.

Hazards for marine mammals can be caused by noise emissions during pile driving of the foundations of offshore wind turbines and converter platforms. Without the use of noise mitigation measures, significant impacts on marine mammals during pile driving could not be excluded. The driving of piles for offshore wind turbines and converter platforms will therefore only be permitted in the specific approval procedure if effective noise mitigation measures are used. The plan sets out principles and objectives in this regard.

These stipulate that the installation of the foundations must be carried out using effective noise reduction measures to comply with applicable noise protection values. In the actual approval procedure, extensive noise reduction measures and monitoring measures are ordered to ensure compliance with applicable noise protection values (sound event level (SEL) of 160 dB re 1µPa²s and maximum peak level of 190 dB re 1µPa at a distance of 750 m around the pile driving or installation site). Suitable measures shall 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 underwater noise mitigation show that the use of appropriate measures can significantly reduce the impact of noise on marine mammals. In addition, the BMUB's noise protection concept has been in force since 2013. According to the noise protection concept, pile driving activities must be coordinated in such a way that sufficiently large areas, especially within the protected areas and the main distribution area of the harbour porpoise in the summer months, are kept free of impacts caused by pile driving noise. Based on current knowledge, significant impacts on marine mammals from the operation of offshore wind turbines and converter platforms can be ruled out.

After implementation of the mitigation measures to be ordered in the individual procedure to comply with applicable noise protection values in accordance with the planning principle, the construction and operation of the planned offshore wind turbines and converter platforms are currently not expected to have any significant adverse impacts on marine mammals. No significant impacts on marine mammals are expected from the laying and operation of submarine cable systems.

The spatial designation of further uses, such as shipping, raw material extraction (especially sand and gravel mining), national and alliance defence and fishing, is not automatically accompanied by increased intensities of use. Rather, these spatial designations are a tracing of previous activities.

11.3.6 Seabirds and resting birds

The EEZ of the North Sea can be subdivided into different sub-areas, each of which has a seabird occurrence to be expected for the respective prevailing hydrographic conditions, the distances to the coast, existing pre-existing pressures and species-specific habitat requirements.

The uses considered in the spatial plan have various impacts on seabirds and resting birds, most of which are both spatially and temporally limited to the area or for the duration of the activity. For species sensitive to disturbance, such as red-throated divers and black-throated divers, offshore wind farm projects have disturbance effects that lead to large-scale avoidance behaviour according to current scientific findings. There are no findings on habituation effects to date. For other species, e.g. common guillemots, there are also findings on avoidance behaviour towards offshore wind farm projects, albeit to a lesser extent than for divers, and with seasonal and site-specific variations.

The designation of areas EN4 and EN5 as reserved areas for offshore wind energy takes account of the review of areas N-4 and N-5 for subsequent use in the 2019 FEP for the protection of divers. In addition, military use should have as little impact as possible on the conservation purpose of the priority area for divers. For the period from 1 March to 15 May of a given year, no encroachment by sand and gravel extraction is to take place in the priority area for common divers, and the Federal Armed Forces authorities and the competent nature conservation authority are to reach agreement on military use (cf. ROP Principle (2) Chap. 2.4 Nature conservation). This takes additional account of the protection of the diver species group, which is sensitive to disturbance, and its particularly important habitat in the EEZ of the North Sea.

Area EN13 considers a distance of 5.5 km from the main concentration area of divers to reduce potential additional habitat loss in the area. By excluding offshore wind energy in the marine nature conservation areas, impacts such as habitat loss in these important habitats are reduced. The spatial plan also designates the nature reserve "Sylt Outer Reef - Eastern German Bight" and the main concentration area for divers in the spring west off Sylt as priority nature conservation areas. Principles of the maritime spatial plan also provide for temporal and spatial coordination in the construction of offshore wind farm projects.

The spatial designation of further uses, such as shipping, raw material extraction (especially sand and gravel mining), national and alliance defence and fishing, is not automatically accompanied by increased intensities of use. Rather, these spatial designations are a tracing of previous activities.

According to current knowledge, the ROP specifications for wind energy in areas EN1 to EN12 do not have any additional or significant impacts on seabirds and resting birds. For the specifications of the expanded priority area EN13 and the conditional priority area EN13-North, this assessment can only be made in consideration of the overall plan assessment of the ROP (cf. Chapter 7).

11.3.7 Migratory birds

The North Sea EEZ has an average to above-average importance for bird migration. It is assumed that considerable population shares of the songbirds breeding in Northern Europe migrate across the North Sea. Specific migration corridors are not identifiable for any migratory bird species in the North Sea EEZ area, as bird migration is either guideline-oriented close to the coast or in a broad-front migration over the North Sea that cannot be further defined. There are indications that migration intensity decreases with distance from the coast, but this has not been clarified for the mass of nocturnal migratory songbirds.

Possible impacts of offshore wind energy on migratory birds may be that they constitute a barrier or collision risk. Excluding wind energy in nature conservation areas reduces collision and barrier effects in important habitats. The other uses considered in the maritime spatial plan do not constitute vertical barriers in space.

According to current knowledge, the spatial planning specifications do not have any significant impacts on migratory birds.

11.3.8 Bats

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

Due to the verticality in the airspace, bats may also be at risk of colliding with offshore wind turbines. According to the current state of knowledge, there are no findings on possible significant impairments of bat migration over the North Sea EEZ. Other uses considered in the maritime spatial plan do not pose comparable obstacles in the airspace.

According to the findings to date, the spatial designations of the maritime spatial plan do not have any significant impacts on bats.

11.3.9 Air

The provisions on wind energy in the ROP do not result in any measurable impacts on air quality. The impact of shipping on air quality is independent of the implementation of the ROP.

11.3.10 Climate

The $_{\text{CO2 savings}}$ associated with the provisions on offshore wind energy can be expected to have a positive impact on the climate in the long term.

11.3.11 Landscape

The impact of the planned wind energy plants in the German EEZ on the coastal landscape can be classified as low. Through coordinated and harmonised overall planning, the provisions of the ROP can minimise the land required for the expansion of offshore wind energy and thus - compared to non-implementation of the plan - also reduce the impacts on the landscape as a protected resource.

Negative impacts on the landscape can be ruled out for the pipelines because they are laid in or on the seabed.

11.3.12 Cultural assets and other material assets

With the further large-scale expansion of wind energy in the German EEZ, known and previously undiscovered cultural assets and traces of settlements may be endangered to a greater extent through damage or destruction. However, this risk can be reduced through comprehensive coordination and agreement measures with the specialist authorities, and at the same time a great gain in knowledge can be expected for underwater archaeology with regard to underwater cultural assets and other cultural traces.

11.3.13 Biodiversity

Biodiversity comprises the diversity of habitats and biotic communities, the diversity of species and the genetic diversity within species (Art. 2 Convention on Biological Diversity, 1992). Biodiversity is the focus of public attention.

With regard to the current state of biodiversity in the North Sea, there is ample evidence of changes in biodiversity and species assemblages 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 control and warning function in this context, as they show the state of the populations of species and biotopes in a region. Possible impacts on biodiversity are dealt with in the environmental report under the individual protected goods. In summary, it can be stated that, according to current knowledge, no significant impacts on biodiversity are to be expected as a result of the ROP specifications.

11.3.14 Interactions

In general, impacts on a protected good lead to various consequences and interactions between the protected goods. The main interdependency of the biotic protected goods exists via the food chains. Possible interactions during the construction phase result from sediment relocation and turbidity plumes as well as noise emissions. However, these interactions only occur for a very short time and are limited to a few days or weeks.

Plant-related interactions, e.g. through the introduction of hard substrate, are expected to be permanent but only local. This could lead to a small-scale change in the food supply.

Due to the variability of the habitat, interactions can only be described very imprecisely. Basically, it can be stated that, according to the current state of knowledge, no interactions are discernible that could result in a threat to the marine environment.

11.3.15 Cumulative effects

Soil, benthos and biotopes

A significant part of the environmental impacts of the areas for offshore wind energy and reserved areas for transmission lines on soil, benthos and biotopes will occur exclusively during the construction period (formation of turbidity plumes, sediment relocation, etc.) and in a spatially limited area. Due to the gradual implementation of the construction projects, construction-related cumulative environmental impacts are unlikely. Possible cumulative impacts on the seabed, which could also have a direct impact on the benthos and specially protected biotopes, result from the permanent direct land use for the foundations of the facilities and the installed pipelines. The individual impacts are generally small-scale and local.

In the area where pipelines are laid, the impairment of 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 shingle beds, permanent impairment would have to be assumed.

With regard to a balance of land use, reference is made to the environmental report on the FEP 2019 or FEP draft 2020. There, the direct land use by wind energy and power cables is estimated on the basis of model assumptions.

Due to the lack of a reliable scientific basis, no statement can be made on the use of specially protected biotopes according to sec. 30 BNatSchG. An area-wide sediment and biotope mapping of the EEZ, which is currently being carried out, will provide a more reliable assessment basis in the future.

In addition to the direct use of the seabed and thus the habitat of the organisms settled there, plant foundations, overlying pipelines and necessary crossing structures lead to an additional supply of hard substrate. This can lead to the settlement of non-native hard substrate-loving species and change the species composition. This effect can lead to cumulative effects through the construction of several offshore structures, pipelines or riprap in crossing areas of pipelines. The hard substrate introduced also results in a loss of habitat for benthic fauna adapted to soft bottoms. However, as the land use for both the grid infrastructure and the wind farms will be within the ‰ range, no significant impacts are to be expected, even in the cumulative effect, which would lead to a threat to the marine environment in relation to the seabed and the benthos.

Fish

The impacts on fish fauna due to the designations are probably most strongly influenced by the realisation of initially 20 GW of wind energy in the reserved areas of the North Sea and Baltic Sea. Here, the impacts of the OWPs are concentrated on the one hand on the regularly ordered closure of the area to fishing, and on the other hand on the change in habitat and its interaction.

The anticipated fishery-free zones within the wind farm areas could have a positive impact on the fish fauna by eliminating negative fishing effects, such as disturbance or destruction of the seabed and catch and bycatch of many species. Due to the lack of fishing pressure, the age structure of the fish fauna could return to a more natural distribution, so that the number of older individuals increases. The OWP could develop into an aggregation site for fish, although it has not yet been conclusively clarified whether wind farms attract fish.

In addition to the absence of fisheries, an improved food base for fish species with a wide variety of diets would also be conceivable. The vegetation of the wind turbines with sessile invertebrates could favour benthophagous species and make a larger and more diverse food source accessible to the fish (Glarou et al. 2020). This could improve the condition of the fish, which in turn would have a positive impact on fitness. Currently, research is needed to translate such cumulative effects to the population level of fish.

There could also be a direct change in species composition, with species with different habitat preferences than the established species, e.g. reef dwellers, finding more favourable living conditions and becoming more abundant. At the Danish wind farm Horns Rev, a horizontal gradient in the occurrence of hard-substrate species between the surrounding sandy areas and near the turbine foundations was observed 7 years after construction: Cliff perch, eelpout and lumpfish occurred much more frequently near the wind turbine foundations than on the surrounding sand flats (LEONHARD et al. 2011). Cumulative effects resulting from extensive offshore wind energy development could include

- an increase in the number of older individuals,
- better conditions for the fish due to a larger and more diverse food base,
- Further establishment and distribution of fish species adapted to reef structures,
- the recolonisation of previously heavily fished areas,
- better living conditions for territorial species such as cod-like fish.

In addition to predation, the natural mechanism for limiting populations is intra- and interspecific competition, which is also called density limitation. It cannot be ruled out that within individual wind farms local density limitation sets in before the favourable effects of the wind farms propagate spatially, 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 might have on other elements of the food web, both below and above their trophic level, cannot be predicted at the current state of knowledge.

Together with the designation of nature conservation areas, wind farm areas could contribute to positive stock developments and thus to the recovery of fish stocks in the North Sea.

Marine mammals

Cumulative impacts on marine mammals, in particular harbour porpoises, may occur primarily due to noise exposure during the installation of deep foundations. Thus, marine mammals can be significantly affected by the fact that - if pile driving is carried out simultaneously at different locations within the EEZ - not enough equivalent habitat is available to avoid and retreat to.

The realisation of offshore wind farms and platforms to date has been relatively slow and gradual. From 2009 to 2018, pile driving was carried out at twenty wind farms and eight converter platforms in the German EEZ of the North Sea. Since 2011, all pile driving has been carried out using technical noise mitigation measures. Since 2014, the noise protection values have been reliably complied with and even undercut thanks to the successful use of noise reduction systems.

The majority of the construction sites were located at distances of 40 to 50 km from each other, so that there was no overlapping of noise-intensive pile driving work that could have led to cumulative effects. Only in the case of the two directly adjacent projects Meerwind Süd/Ost and Nordsee Ost in Area 4 was it necessary to coordinate the pile-driving work, including the measures to confine the birds.

The evaluation of the sound results with regard to sound propagation and the possibly resulting accumulation has shown that the propagation of impulsive sound is strongly restricted when effective sound minimising measures are applied (BRANDT et al. 2018, DÄHNE et al., 2017).

Cumulative effects of the plan on the harbour porpoise population are considered in accordance with the requirements of the BMU noise protection concept of 2013. In order to avoid and reduce cumulative impacts on harbour porpoise populations in the German EEZ, a restriction of sound emissions from habitats to maximum permitted areas of the EEZ and nature conservation areas is specified in the downstream approval procedure. Accordingly, the propagation of sound emissions may not exceed defined areas of the German EEZ and nature conservation areas. This ensures that sufficient high-quality habitats are available to animals for escape at all times. The order primarily serves to protect marine habitats by avoiding and minimising disturbances caused by impulsive sound emissions.

Specifically, the order provides for the following in the downstream approval notices:

- It shall be ensured with the necessary certainty that at any time no more than 10% of the area of the German EEZ of the North Sea and no more than 10% of a neighbouring nature conservation area is affected by noise-inducing pile driving activities.
- During the porpoise's sensitive period from 1 May to 31 August, it shall be ensured with the necessary certainty that no more than 1% of sub-area I of the nature conservation area "Sylt Outer Reef - Eastern German Bight" with its special function as a nursery area is affected by sound-intensive pile-driving work for the foundation of the piles from disturbance-triggering sound inputs.

By designating the area of conservation concern for harbour porpoises, the standards for the protection of impulsive noise emissions that apply to projects in and around the nature conservation area "Sylt Outer Reef - Eastern German Bight" will in future also apply to projects in and around the area of conservation concern in the context of downstream approval procedures.

The harbour porpoise reserve in the summer months comprises the protected area "Sylt Outer Reef" and its immediate surroundings. Pile driving activities that have the potential to cause disturbance due to noise in the main concentration area of the harbour porpoise during the sensitive season are coordinated in such a way that the proportion of the area affected always remains below 1%. In accordance with the BMU's noise protection concept (2013), all pile-driving activities are coordinated with the aim of ensuring that there are always sufficient alternative sites in the protected areas, in equivalent habitats and in the entire German EEZ.

In conclusion, the implementation of the plan will lead to avoidance and mitigation of cumulative impacts. This assessment also applies with regard to cumulative impacts of the various uses on marine mammals.

Seabirds and resting birds

In order to assess the significance of cumulative effects on seabirds and resting birds, any impacts must be assessed on a species-specific basis. In particular, species of Annex I of the V-Directive, species of sub-area II of the nature reserve "Sylt Outer Reef - Eastern German Bight" and such species for which an avoidance behaviour towards structures has already been determined have to be considered with regard to cumulative effects.

When assessing the cumulative effects of offshore wind farms, special attention must be paid to the group of divers, including the endangered and sensitive species of red-throated and black-throated divers. GARTHE & HÜPPOP (2004) attest divers a very high sensitivity to structures. For the consideration of cumulative effects, neighbouring wind farms as well as those located in the same contiguous functional spatial unit defined by physically and biologically significant properties for a species have to be taken into account. Furthermore, in addition to the structures themselves, impacts from vessel traffic (including for the operation and maintenance of cables and platforms) must also be included. Current findings from studies confirm the scaring effect on divers triggered by ships. Red-throated and black-throated divers are among the most sensitive bird species in the German North Sea to ship traffic (MENDEL et al. 2019, FLIESSBACH et al. 2019, BURGER et al. 2019).

The main concentration area takes into account the most important period for the species, the spring. Based on the data available at the time the main concentration area was defined in 2009, the main concentration area accommodates approx. 66% of the diver population in the German North Sea and approx. 83% of the EEZ population in spring and is therefore particularly important from a population biology point of view (BMU 2009) and an important functional component of the marine environment with regard to seabirds and resting birds. Against the background of current population calculations, 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 delineation of the main concentration area for divers is based on the data situation, which is considered to be very good, and on technical analyses that find broad scientific acceptance. The area includes all areas of very high and most of the areas of high diver density in the German Bight. The designation of the main concentration area of common divers in the German EEZ of the North Sea as part of the BMU position paper (2009) represents an important measure to ensure species protection of the nuisance-sensitive species stern and black-throated divers. The BMU decreed that in the context of 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.

Current results from operational monitoring of offshore wind farms and from research projects, some of which used study methods independent of the standardised monitoring according to the standard study concept (StUK) (e.g. telemetry study within the framework of the DIVER project), consistently show that the avoidance behaviour of divers towards offshore wind farms is far more pronounced than had been anticipated in the original approval decisions of the wind farm projects (cf. Chapter 3.2.5).

Interim results of a study by the FTZ were presented at the BSH's Marine Environmental Symposium in 2018. The evaluations have since been published (GARTHE et al. 2018, SCHWEMMER et al. 2019). The cumulative consideration of the avoidance behaviour of divers towards offshore wind farms resulted in a calculated complete habitat loss of 5.5 km and a statistically significant decrease in abundance up to a distance of 10 km, starting from the periphery of a wind farm (GARTHE et al. 2018). For the statistically significant decrease in abundance, this is not a total avoidance, but a partial avoidance with increasing diver densities up to a distance of 10 km from a wind farm. The calculated complete habitat loss of 5.5 km is used to quantify the habitat loss in analogy to the former shy distance of 2 km. It is subject to the purely statistical assumption that no divers occur up to a distance of 5.5 km from an offshore wind farm. Another cross-project study on the occurrence and distribution of divers and the effects of offshore wind farm projects on divers in the German North Sea, commissioned by the BWO, provided comparable results with a significant avoidance distance of 10 km and a calculated complete habitat loss of approx. 5 km across all realised wind farm projects. The results from GARTHE et al. (2018) regarding the avoidance behaviour of divers are thus confirmed by an independent study (BIOCONSULT SH et al. 2020).

In summary, the results from monitoring as well as from research projects consistently show that the avoidance behaviour of common divers towards offshore wind farms is far more pronounced than previously assumed. A population calculation for the main concentration area as part of the FTZ diver study commissioned by BfN and BSH showed an increase in the common diver population for the period 2002 to 2012, which has remained at a relatively constant high level since 2012. However, for the entire German North Sea, whose sub-areas have locally varying importance as habitat for divers, a decrease in the common diver population has been observed since 2012 (observation period until 2017) (SCHWEMMER et al. 2019). The study commissioned by the BWO yields qualitatively and quantitatively comparable population figures and population trends for the main concentration area and the German North Sea. Differences can be attributed to different stock calculation methodologies and modified data bases.

Both studies confirm the overall high and special functional importance of the main concentration area as habitat for divers in the German North Sea (SCHWEMMER et al. 2019, BIOCONSULT SH et al. 2020). This applies in particular against the background of the pronounced avoidance behaviour and associated habitat loss.

The main concentration area represents a particularly important component of the marine environment with regard to seabirds and resting birds, especially with regard to the diver species group. The spatial planning designation of the main concentration area for common divers as a reserved area, according to which the planning, construction and operation of energy production facilities in the main concentration area for common divers should not take place if this leads to a significant impairment of the habitat of the common diver, takes particular account of the protection of common divers in this particularly important habitat, especially against the background of the observed avoidance behaviour from the operational phase of the OWPs in the North Sea EEZ. The designation of areas EN4 and EN5 within the main concentration area as reserved areas for offshore wind energy takes up the review of areas N-4 and N-5 for subsequent use in the FEP 2019 (BSH 2019) and FEP 2020 (BSH 2020a) at spatial planning level. In addition, military use should have as little impact as possible on the conservation purpose of the priority area for divers. For the period from 1 March to 15 May of a given year, no encroachment by sand and gravel extraction should occur in the priority area for divers, and the Federal Armed Forces authorities and the competent nature conservation authority should reach agreement on military use (cf. ROP Principle (2) Chap. 2.4 Nature conservation). This takes additional account of the protection of the diver species group, which is sensitive to disturbance, and its particularly important habitat in the North Sea EEZ. The designation of the reserved areas for common divers (StN1 to StN3) also takes account of the sustainable use of the reserved areas EN4 and EN5.

However, according to the current state of knowledge, it must be assumed that the wind farm projects to be realised on EN13 will have a shying effect on the priority area divers to the extent identified and that it must therefore be examined in the individual procedure to what extent avoidance and reduction measures must be used for the specific turbines applied for.

The designations of other uses are located outside the main diver concentration area in areas that are of lesser importance for divers and/or refer to uses whose effects are mostly temporary and local (cf. corresponding subchapters in Chapters 3 and 4).

For other species of seabirds and resting birds, it can be assumed that the specifications and principles relating to divers and the main concentration area will also have a positive effect. The priority areas for nature conservation contribute to the protection of open spaces, as they exclude uses that are incompatible with nature conservation. These designations protect important habitats and reduce habitat impairments and collision risks there. Outside the nature conservation areas, some species occur over large areas within the EEZ without clear distribution centres (see Chapter 2.9.2). Moreover, the impacts of some uses are often local and limited to the duration of the use (cf. corresponding subchapters in Chapters 3and 4). In addition, some spatial planning regulations, e.g. on shipping, are not expected to lead to an increase in density or intensity of use, but rather to replications of existing levels of activity.

As a result of the SEA, significant cumulative impacts of the spatial planning specifications on the protected species of seabirds and resting birds are not to be expected according to the current state of knowledge. For the specifications for the expanded priority area EN13 and the conditional priority area EN13-North in relation to the main concentration area, this assessment can only be made taking into account the overall plan assessment of the ROP (cf. Chapter 7).

Migratory birds

The designation of priority and reserved areas for offshore wind energy in a spatial context to each other and the exclusion of offshore wind energy in nature conservation areas will reduce barrier effects and collision risks in important feeding and resting habitats. The impacts of the other uses or their specifications are comparatively less extensive in terms of verticality in the airspace.

According to the current state of knowledge, significant cumulative impacts of the spatial planning specifications of all considered uses on migratory birds can be excluded with the necessary certainty.

11.3.16 Cross-border effects

The SEA concludes that, as things stand at present, no significant impacts on the areas of neighbouring states adjacent to the German EEZ in the North Sea are discernible as a result of the stipulations made in the ROP.

For the protected goods soil, water, plankton, benthos, biotope types, landscape, cultural heritage and other material goods and the protected good human beings and human health, significant transboundary impacts can be excluded in principle.

For fish, the SEA concludes that, according to the current state of knowledge, no significant transboundary impacts on fish are to be expected as a result of the implementation of the ROP, since, on the one hand, the areas designated in the ROP do not have a prominent function for fish fauna and, on the other hand, the recognisable and predictable effects are of a small-scale and temporary nature.

According to the current state of knowledge and taking into account impact-minimising and damage-limiting measures, significant transboundary impacts on marine mammals can also be ruled out. For example, the installation of wind turbine foundations and converter platforms will only be permitted in the specific approval procedure if effective noise abatement measures are used.

For the protected species of seabirds and resting birds, the Danish bird sanctuary "Sydlige Nordsø", which directly borders the German EEZ to the north and also has a high occurrence of divers, must be taken into account when considering possible significant transboundary impacts. According to the information available to date, the maritime spatial plan is not expected to have any significant impacts.

For migratory birds, erected wind turbines in particular can represent a barrier or collision risk. By designating areas for wind energy exclusively outside marine nature conservation areas, these impacts are reduced in important resting areas for some migratory bird species. The other uses considered in the maritime spatial plan do not have comparable spatial impacts. According to the current state of knowledge, no significant transboundary impacts on migratory birds are to be expected from the specifications in the maritime spatial plan.

11.4 Species protection law assessment

The species protection assessment examines whether the plan meets the requirements of sec. 44 para. 1 no. 1 and no. 2 BNatSchG for specially and strictly protected animal species. In particular, it is examined whether the plan violates species protection prohibitions.

According to sec. 44 para. 1 no. 1 BNatSchG, killing or injuring wild animals of specially protected species, i.e. animals listed in Annex IV of the Habitats Directive and Annex I of the V Directive, is prohibited. The species protection assessment pursuant to Article 44(1)(1) of the Federal Nature Conservation Act always refers to the killing and injury of individuals.

Pursuant to sec. 44 para. 1 no. 2 BNatSchG, it is also prohibited to significantly disturb wild animals of strictly protected species during the breeding, rearing, moulting, hibernation and migration periods, whereby significant disturbance exists if the disturbance worsens the conservation status of the local population of a species.

Protected marine mammal species

The update of the plan contains principles according to which the input of noise into the marine environment during the construction of installations is to be avoided in accordance with the state of the art in science and technology and an overall coordination of the construction work of spatially co-located installations is to take place. Noise abatement measures are to be used. On this basis, the BSH may order appropriate concretisation with regard to individual work steps, such as deterrence measures and a slow increase in pile driving energy, by means of so-called "soft start" procedures within the framework of subordinate procedures, the site development plan, the suitability assessment of sites and, in particular, within the framework of the respective individual licensing procedures as well as within the framework of enforcement. The use of deterrence measures and soft-start procedures can 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.

The scope of the measures prevents, with sufficient certainty, the fulfilment of the prohibitions of species protection under Article 44(1)(1) of the Federal Nature Conservation Act (BNatSchG).

According to the current state of knowledge, neither the operation of the turbines nor the laying and operation of the cabling within the park will have any significant negative impacts on marine mammals that fulfil the killing and injury requirements of Article 44 (1) no. 1 of the Federal Nature Conservation Act (BNatSchG).

The temporary execution of the pile driving work is not expected to cause any significant disturbance to harbour porpoises within the meaning of

Article 44 (1) no. 2 of the Federal Nature Conservation Act.

According to the current state of knowledge, it is not to be assumed that disturbances that may occur due to sound-intensive construction measures, and provided that avoidance and mitigation measures are implemented, would worsen the conservation status of the local population. A local population comprises those (partial) habitats and activity areas of the individuals of a species that have a spatial-functional relationship sufficient for the habitat (space) requirements of the species. A deterioration of the conservation status is to be assumed in particular if the chances of survival, breeding success or reproductive capacity are reduced, whereby this must be examined and assessed on a species-specific basis for each individual case (cf. legal justification for the BNatSchG amendment 2007, BT-Drs. 11).

Through effective noise abatement management, in particular through the application of suitable noise abatement systems in accordance with the principles and objectives in the update of the plan as well as subsequent orders in the individual approval procedure of the BSH and taking into account the specifications from the noise abatement concept of the BMU (2013), negative impacts of the pile driving work on harbour porpoises are not to be expected.

The decisions of the BSH will include concretising orders that ensure effective noise abatement management through appropriate measures.

- Preparation of a sound prognosis taking into account the site- and plant-specific properties (basic design) before the start of construction,
- Selection of the erection method with the lowest noise level according to the state of the art and the existing conditions,
- Preparation of a concretised soundproofing concept adapted to the selected foundation structures and erection processes for the execution of pile driving works in principle two years before the start of construction, in any case before the conclusion of contracts regarding the sound-relevant components,
- Use of sound-reducing accompanying measures, individually or in combination, away from the pile (bubble curtain system) and, if necessary, also close to the pile, according to the state of the art in science and technology,
- Consideration of the characteristics of the hammer and the possibilities of controlling the pile driving process in the sound insulation concept,
- Concept for the removal of animals from the hazard area (at least within a radius of 750 m around the pile driving site),
- Concept for verifying the efficiency of the deterrence and sound-reducing measures,
- Operating noise-reducing system design according to the state of the art.

In order to avoid cumulative impacts due to parallel pile driving at different projects, a temporal coordination of pile driving is ordered within the framework of subordinate planning approval procedures and enforcement in accordance with the requirements of the BMU noise protection concept (2013). The noise protection concept of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) (2013) pursues an area-based approach with the aim of maintaining sufficient high-quality alternative habitats for harbour porpoise stocks in the German EEZ of the North Sea free of disturbance-triggering noise inputs.

As a result, if the above-mentioned strict noise protection and noise reduction measures are applied in accordance with the principles and objectives of the plan and the orders in the planning approval decisions, taking into account the noise protection concept of the BMU (2013) and compliance with the limit value of 160 dB SEL5 at a distance of 750 m, significant disturbances within the meaning of sec. 44 para. 1 no. 2 BNatSchG are not to be feared.

According to the current state of knowledge, the operation of offshore wind turbines cannot be assumed to cause disturbance pursuant to Article 44 para. 1 no. 2 of the Federal Nature Conservation Act.

Spatial planning and the provisions of the plan, including the principles and objectives, are among the central instruments for mitigating or even avoiding cumulative impacts on the harbour porpoise population through the equalisation of spatial conflicts between uses and the designation of priority and reserved areas for nature conservation.

The designation of priority areas for wind energy exclusively outside nature conservation areas is a measure to ensure the protection of harbour porpoises in the German EEZ. In addition, spatial planning paves the way for downstream planning levels and procedures. Finally, the principles of the plan form the backbone for the specifications in the subordinate procedures and for the orders for the protection of harbour porpoises in the context of individual approval procedures.

The noise protection concept of the BMU for the North Sea of 2013 also includes a number of requirements through the habitat approach pursued, which ensure effective avoidance and reduction of cumulative impacts from pile driving on the local population of harbour porpoise in the German EEZ and on the populations in the nature conservation areas. The present plan has identified the main concentration area of harbour porpoise in the German EEZ of the North Sea as a reserved area for harbour porpoise during the sensitive period from 1 May to 31 August, as part of the preparation of the BMU noise protection concept (2013). Within the framework of the subordinate procedures or in individual approval procedures for the uses, the special requirements from the BMU's noise protection concept are ordered in the nature conservation areas as well as in the reserved area.

In conclusion, it can be stated with regard to the harbour porpoise that the implementation of the plan does not fulfil the prohibition criteria of sec. 44 para. 1 no. 1 and no. 2 BNatSchG, also with regard to cumulative impacts.

Cumulative view

In Chapter 4.11.3cumulative effects of offshore wind energy production on harbour porpoises were presented and avoidance and mitigation measures were described at the same time. However, the harbour porpoise is exposed to the effects of various anthropogenic uses as well as natural and climate-related changes. A differentiation or even weighting of the share of the impacts caused by an individual use on the status of the population is hardly possible scientifically. The designation of priority areas for wind energy exclusively outside nature conservation areas is a measure to ensure the protection of harbour porpoises in the German EEZ. In addition, spatial planning paves the way for downstream planning levels and procedures. Finally, the principles of the plan form the backbone for the specifications in the subordinate procedures and for the orders for the protection of harbour porpoises in the context of individual approval procedures.

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In conclusion, it can be stated with regard to the harbour porpoise that the implementation of the plan does not fulfil the prohibition criteria of sec. 44 para. 1 no. 1 and no. 2 BNatSchG, also with regard to cumulative impacts.

Protected seabird species

Pursuant to sec. 44 para. 1 no. 1 BNatSchG in conjunction with Art. 5 V-RL, it is prohibited to hunt wild animals of protected species. 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 the species listed in Annex I of the V-RL, species whose habitats and habitats are protected in the nature conservation areas and in the reserved area for divers, as well as characteristic species of the areas in the plan. Accordingly, injury or killing of resting birds as a result of collisions with wind turbines must be excluded. The risk of collision depends on the behaviour of the individual animals and is directly related to the species concerned and the environmental conditions encountered. For example, divers are not expected to collide with wind turbines due to their distinct avoidance behaviour towards vertical obstacles.

However, the measures ordered, such as minimising light emissions, ensure that a collision with the offshore wind turbines is avoided as far as possible or that this risk is at least minimised. In addition, monitoring is carried out during the operational phase to enable an improved nature conservation assessment of the actual bird strike risk posed by the turbines. The order of further measures is also regularly expressly reserved. Against this background, the BSH estimates that there is no significant increase in the risk of death or injury to migratory birds.

It can therefore not be assumed that the prohibition of injury and killing of sec. 44 para. 1 no. 1 BNatSchG is realised.

As a result, the SEA assessments for the FEP 2019 and FEP 2020 have shown that divers are highly sensitive in terms of population biology, that the main concentration area is of high importance for the conservation of the local population, and that the adverse effects due to avoidance behaviour are intense and permanent.

In order to avoid a deterioration of the conservation status of the local population due to the cumulative impacts of the wind farms, it is necessary to keep the area of the main concentration area currently available to divers, outside the impact zones of already realised wind farms, free of new wind farm projects.

For the detailed assessment, please refer to the species protection assessment on the FEP 2019 and FEP 2020.

Finally, for offshore wind farms in areas EN1 to EN12, as well as EN14 to EN19, it is not assumed, based on the current state of knowledge, that the disturbance requirement under Article 44(1)(2) of the Federal Nature Conservation Act is met. For the specifications for the extended priority area EN13 and the conditional priority area EN13-North, this assessment can only be made taking into account the overall plan assessment of the ROP (cf. Chapter 7).

Based on the findings on the avoidance behaviour of divers towards offshore wind energy presented in 3.2.5, it must be assumed, according to the current state of knowledge, that the wind farm projects to be realised on EN13 will have a shying effect on the priority area for divers to the extent identified. The same assumptions apply to the conditional priority area EN13-North, insofar as the area becomes a priority area for wind energy from 01.01.2030. Therefore, the extent to which avoidance and mitigation measures must be used must be examined in the individual procedure for the specific turbines applied for.

<u>Cumulative impacts</u>

Seabirds are exposed to the effects of various anthropogenic uses as well as natural and climate-related changes. A differentiation or even weighting of the share of the impact of a single use on the status of the respective population of a species is hardly possible scientifically.

Since 2009, the BSH has carried out qualitative assessments of cumulative effects on divers within the framework of approval procedures for offshore wind farms, using the main concentration area in accordance with the position paper of the BMU (2009). The cumulative consideration of the avoidance behaviour of divers towards offshore wind farms in the context of studies commissioned by the BSH and the BfN resulted in a calculated complete habitat loss of 5.5 km and a statistically significant decrease in abundance up to a distance of 10 km, starting from the periphery of a wind farm (GARTHE et al. 2018). For the statistically significant decrease in abundance, this is not a total avoidance but a partial avoidance with increasing diver densities up to a distance of 10 km from a wind farm.

Planning wind energy production outside nature conservation areas is a fundamental measure to ensure the protection of seabird species in the German EEZ. In addition, spatial planning paves the way for further measures, such as the preparation of the land development plan and the preliminary investigation and examination of the suitability of areas for offshore wind energy. Finally, the principles of the plan form the backbone for the specifications in the subordinate procedures and for the orders for the protection of harbour porpoises in the context of individual approval procedures.

The BMU position paper (2009) on the protection of common divers provides the foundation for the assessment of cumulative effects from wind energy generation. The designation of the identified main concentration area as a priority area for the protection of common divers represents the most important avoidance and mitigation measure to exclude cumulative effects at population level. Due to its special location in the area of the frontal system west of the North Frisian Islands with its very high productivity and the resulting rich food supply, the reserved area represents an area protected in addition to the three nature conservation areas for the strictly protected as well as for the characteristic seabird species of the German EEZ in the North Sea.

Finally, for offshore wind farms in areas EN1 to EN12, as well as EN14 to EN19, it is not assumed, based on the current state of knowledge, that the disturbance requirement under Article 44(1)(2) of the Federal Nature Conservation Act is met. For the specifications for the extended priority area EN13 and the conditional priority area EN13-North, this assessment can only be made taking into account the overall plan assessment of the ROP (cf. Chapter 7).

Based on the findings on the avoidance behaviour of divers towards offshore wind energy presented in 3.2.5, it must be assumed, according to the current state of knowledge, that the wind farm projects to be realised on EN13 will have a shying effect on the priority area for divers to the extent identified. The same assumptions apply to the conditional priority area EN13-North, insofar as the area becomes a priority area for wind energy from 01.01.2030. Therefore, the extent to which avoidance and mitigation measures must be used must be examined in the individual procedure for the specific turbines applied for.

Bats

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

According to expert knowledge, the risk of isolated collisions with wind turbines cannot be ruled out.

However, it can be assumed that any negative impacts of wind turbines on bats will be avoided by the same avoidance and mitigation measures provided for the protection of bird migration.

According to the plans currently envisaged, neither the killing and injury provisions of Article 44(1)(1) of the Federal Nature Conservation Act nor the species protection prohibition of significant disturbance pursuant to Article 44(1)(2) of the Federal Nature Conservation Act are to be expected.

11.5 Impact assessment

Insofar as a site of Community importance or a European bird sanctuary may be significantly impaired in terms of its components relevant to the conservation objectives or the purpose of protection, sec. 7 para. 6 in conjunction with sec. 7 para. 7 of the ROG must be applied when amending and supplementing maritime spatial plans. Para. 7 ROG, the provisions of the Federal Nature Conservation Act on the admissibility and implementation of such interventions, including obtaining the opinion of the European Commission, must be applied when amending and supplementing maritime spatial plans.

The impact assessment carried out here basically takes place at the superordinate level of spatial planning and sets a framework for subordinate planning levels with regard to long-distance effects, insofar as these exist. It therefore does not replace the assessment at the level of the specific project in knowledge of the specific project parameters, which is carried out within the framework of approval procedures. In this respect, further avoidance and mitigation measures are to be expected if these are deemed necessary by the impact assessment within the framework of approval procedures in order to exclude any impairment of the conservation objectives of the Natura2000 sites or the conservation purposes of the protected areas by the use within or outside a nature conservation area. At the same time, it must be taken into account that for some uses - especially wind energy - the ROP traces the projects already in operation and the specifications of the FEP sectoral planning, for which impact assessments have already been carried out.

Prior to their designation as marine protected areas under sec. 20 para. 2, 57 of the Federal Nature Conservation Act (BNatSchG), the nature conservation areas in the EEZ were included in the first updated list of sites of Community importance in the Atlantic biogeographical region pursuant to Article 4 para. 2 of the Habitats Directive by decision of the EU Commission of 12.11.2007 (Official Journal of the EU, 15.01.2008, L 12/1), so that an Habitats Impact Assessment had already been carried out as part of the Federal Sectoral Plan Offshore for the German EEZ of the North Sea (BSH 2017). Most recently, an impact assessment according to sec. 34 para. 1 in conjunction with sec. 36 BNatSchG was carried out. 36 of the Federal Nature Conservation Act (BNatSchG) was carried out as part of the SEA for the area development plan (BSH, 2019).

In the German EEZ of the North Sea, there are the nature conservation areas "Sylter Außenriff - Östliche Deutsche Bucht" (Ordinance on the Establishment of the Nature Conservation Area "Sylter Außenriff - Östliche Deutsche Bucht" of 22. September 2017 (NSGSylV)), "Borkum Riffgrund" (Ordinance on the Establishment of the Nature Reserve "Borkum Riffgrund" of 22 September 2017 (NSGBRgV)) and "Doggerbank" (Ordinance on the Establishment of the Nature Reserve "Doggerbank" of 22 September 2017 (NSGDgbV)).

The total area of the three nature conservation areas in the German EEZ of the North Sea is 7,920 km2, of which 625 km2 belong to the nature conservation area "Borkum Riffgrund", 5,603 km2 to the nature conservation area "Sylter Außenriff - Östliche Deutsche Bucht" and 1,692 km2 to the nature conservation area "Doggerbank".

Within the framework of the impact assessment, 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 biotic communities and species, as well as protected species, specifically fish (river lamprey, fin), marine mammals according to Annex II of the Habitats Directive (harbour porpoise, grey seal and harbour seal) as well as protected bird species according to Annex I of the Birds Directive (in particular red-throated diver, black-throated diver, little gull, Sandwich, common and Arctic tern) and regularly occurring migratory bird species (in particular storm and herring gull, fulmar, gannet, kittiwake, guillemot and razorbill).

The impact assessment also takes into account the long-distance effects of the specifications made within the EEZ on the protected areas in the adjacent 12-nautical-mile zone and in the adjacent waters of neighbouring states.

Due to the exclusion of designations of areas and sites for wind energy in the nature conservation areas in the FEP, construction, installation and operational impacts on the FFH habitat types "reef" and "sandbank" with their characteristic and endangered biotic communities and species can be excluded. The areas are located far outside the drift distances discussed in the literature, so that no release of turbidity, nutrients and pollutants is to be expected that could impair the nature conservation and FFH areas in their components relevant to the conservation objectives or the conservation purpose.

Whether the specifications lead to impairments of habitat types must be assessed prognostically, taking into account project-specific effects.

For the sections of the pipeline corridors LN1 and LN14 located in the area of the habitat type "sandbanks with only slight permanent overtopping by seawater" (EU Code 1110), it must be ensured that the orientation values for the relative and absolute area loss according to Lambrecht & Trautner (2007) and Bernotat (2013) are not exceeded.

The assessment of the compatibility of the plan with regard to the strictly protected species harbour porpoise has shown with regard to long-distance effects that, according to current knowledge, a significant impairment of the conservation objectives of the nature conservation areas can be ruled out with the necessary certainty through the implementation of the ordered noise protection measures.

The ROP also provides for the designation of a reserved area for harbour porpoises in the German EEZ of the North Sea. The reserved area represents the main concentration area of the harbour porpoise during the sensitive period from 1 May to 31 August, which was identified as part of the development of the BMU noise protection concept (2013). The seasonal reserved area of the harbour porpoise comprises Area I of the nature conservation area "Sylt Outer Reef - Eastern German Bight" and its surroundings. In physical terms, the reserved area thus generously encompasses the area of the frontal system west of the North Frisian Islands. Due to weather and currents, the frontal system spreads very dynamically into the reserved area and ensures increased productivity and rich food supply for TOP predators, such as harbour porpoise and many seabird species. By designating the seasonal reserved area, the maritime spatial plan takes a preventive measure to secure the food-rich alternative habitat of the harbour porpoise outside Area I of the nature reserve.

Various measures to protect the divers have already been defined within the framework of the FEP. In addition to the preventive measure of the BMU (2009) by restricting offshore wind energy within the main concentration area of the divers, the exclusion of the offshore wind farm "Butendiek" for a possible subsequent use also represents a significant mitigation measure. Finally, the requirement for an assessment in the context of the land development plan of a possible subsequent use of areas EN4 and EN5 constituted a further monitoring measure.

The update of the ROP also provides for the designation of a priority area for common divers in the German EEZ of the North Sea. The priority area represents the main concentration area of divers during spring in the German EEZ, which was identified in the context of the preparation of the BMU position paper (2009). The priority area covers Area II of the nature reserve "Sylt Outer Reef - Eastern German Bight" and its surroundings. In physical terms, the priority area thus generously encompasses the area of the frontal system west of the North Frisian Islands. The frontal system spreads into the priority area very dynamically due to weather and currents and ensures increased productivity and rich food supply for top predators such as divers but also many other seabird species. By designating the reserved area, the maritime spatial plan takes a preventive measure to safeguard the divers' food-rich alternative habitat outside Area II of the nature reserve.

Taking into account the measures mentioned above, which ensure the protection of divers within but also outside the nature reserve "Sylt Outer Reef - Eastern German Bight", a significant impairment of the conservation objectives can be excluded with the necessary certainty.

11.6 Measures to avoid, reduce and compensate for significant negative impacts of the land development plan on the marine environment

Pursuant to No. 2 c) Annex 1 to sec. 8 para. 1 ROG, the environmental report shall contain a description of the measures planned to prevent, reduce and, as far as possible, compensate for significant adverse environmental effects resulting from the implementation of the plan.

In principle, the ROP takes better account of the needs of the marine environment. The provisions of the ROP avoid negative impacts on the marine environment. This is due in particular to the fact that it is not apparent that the uses would not take place or would take place to a lesser extent if the plan were not implemented. The need to develop offshore wind energy and the corresponding connection lines exists in any case and the corresponding infrastructure would have to be created even without the ROP (cf. Chap. 3.2). However, if the plan were not implemented, the uses would develop without the land-saving and resource-saving control and coordination effect of the ROP.

In addition, the provisions of the ROP are subject to a continuous optimisation process, as the insights gained on an ongoing basis during the SEA and consultation process are taken into account in the preparation of the plan.

While individual avoidance, mitigation and compensation measures can already be implemented at the planning level, others only come into effect during concrete implementation and are regulated there in the individual approval procedure on a project- and site-specific basis.

With regard to planning avoidance and mitigation measures, the ROP makes spatial and textual specifications which, in accordance with the environmental protection objectives set out in Chapter 1.4serve to avoid or reduce significant negative impacts of the implementation of the ROP on the marine environment. This includes, among other things, spatial specifications for priority areas for nature conservation and other ecologically valuable areas, the exclusion of uses in priority areas for nature conservation that are not compatible with nature conservation, the principle of noise reduction in the construction of wind turbines, and the principle of taking into account best environmental practice in accordance with the OSPAR Convention and the respective state of the art in science and technology in economic and scientific uses.

Minimising land consumption is ensured by the following principles:

- Economic uses should be as space-saving as possible.
- After the end of use, fixed installations must be dismantled.
- When laying pipelines, the aim should be to achieve the greatest possible bundling in the sense of parallel routing. In addition, the routing should be as parallel as possible to existing structures and buildings.

In addition to the aforementioned measures at the plan level, there are measures for the avoidance and mitigation of insignificant and significant negative impacts in the concrete implementation of the ROP for certain designations or associated uses, such as offshore wind energy, pipelines and sand and gravel extraction. These mitigation and avoidance measures are specified and ordered by the respective competent approval authority at project level for the planning, construction and operational phases.

11.7 Alternative assessment

Pursuant to Art. 5 para. 1 sentence 1 SEA Directive in conjunction with the criteria in Annex I SEA Directive and sec. 40 para. 2 No. 8 UVPG, the environmental report contains a brief description of the reasons for the choice of the reasonable alternatives examined in the course of preparing the draft spatial plan. At the plan level, the conceptual/strategic design and spatial alternatives play a role.

In principle, it should be noted that a preliminary assessment of possible and conceivable planning options is already inherent in all specifications in the form of spatial planning objectives and principles. As can be seen from the justification of the individual objectives and principles, especially those with environmental relevance, the respective determination is already based on a consideration of possible affected public concerns and legal positions, so that a "preliminary examination" of possible planning options or alternatives has already taken place.

In detail, in addition to the zero alternative, spatial planning options or alternatives in particular are examined within the framework of the environmental assessment, insofar as they are relevant for the individual uses.

The planning concept and the planning guidelines (ROP, Chapter 1) form the basis for the planning solutions to be examined and for the examination of alternatives. Whereas initially three overall plan alternatives were examined in the context of the preparation of the planning concept on the basis of selected environmental aspects, in particular individual area designations, further (partial) spatial alternatives or different spatial planning areas (such as priority areas, reserved areas) were considered and assessed from an environmental perspective for the preparation of the first draft plan. Area designations for wind energy in the outer EEZ are subject to a detailed environmental assessment at subordinate planning levels.

The zero alternative is not assessed as a reasonable alternative for the update of the maritime spatial plan, as requirements and spatial claims have changed considerably since the ROP 2009 came into force, and the need for more far-reaching specifications has become clear, particularly for nature conservation. The draft plan is likely to lead to a comparatively lower overall land use and thus to lower environmental impacts due to more comprehensive and forward-looking planning and coordination, taking into account a large number of spatial claims (cf. Chap. 3).

The preferred planning solution from an environmental point of view was not included in the draft plan in all cases. Rather, the overall context of the plan had to be considered, and in the choice of planning solutions, in addition to taking nature conservation concerns and the avoidance or reduction of possible negative environmental impacts into account, a balance with other economic, scientific and safety concerns had to be sought as far as possible in the overall view. The decisive factor is that, at the level of this SEA, no significant impacts on the marine environment are to be expected for the specifications made in the maritime spatial plan according to the current state of knowledge.

11.8 Planned measures for monitoring the effects of the implementation of the maritime spatial plan on the environment

According to No. 3 b) Annex 1 to sec. 8 para. 1 ROG, the environmental report also contains a description of the planned monitoring measures. Monitoring is necessary, in particular, to identify unforeseen significant impacts at an early stage and to be able to take appropriate remedial action.

The monitoring also serves to verify the gaps in knowledge set out in the environmental report and the forecasts that are subject to uncertainties. The results of the monitoring are to be taken into account in the updating of the ROP in accordance with sec. 45 para. 4 UVPG.

The actual monitoring of potential impacts on the marine environment can only begin when the uses regulated under the plan are realised. Therefore, project-related monitoring of the impacts of offshore wind farms, pipelines and resource extraction is of particular importance. The main task of monitoring is to bring together and evaluate the findings from the various monitoring results at project level. In addition, existing national and international monitoring programmes must be taken into account, also to avoid duplication of work.

The investigation of the potential environmental impacts of areas for wind energy must be carried out at the downstream project level in accordance with the standard "Investigation of impacts of offshore wind turbines (StUK4)" and in consultation with the BSH.

With regard to the specific measures for monitoring the potential impacts of wind energy use, including impacts from power cables, reference is made to the detailed explanations in the Environmental Report on the FEP 2019/ Draft FEP 2020.

For the approval of areas for sand and gravel extraction, for example, it applies that, before the next main operating plan approval, it must be demonstrated by suitable monitoring that the maximum permitted extraction depth is not exceeded, the original substrate is preserved and sufficient unmined areas remain so that the recolonisation potential is given.

For pipelines, monitoring measures during the construction phase include documentation of turbidity plumes, hydro-sound measurements and surveys of marine mammals and seabirds and resting birds. Essential monitoring measures during the operational phase of pipelines include annual documentation of the positional stability of the pipeline and the cover heights as well as annual documentation of the epifauna on the overlying pipeline for a period of five years after commissioning.

The BSH is conducting a whole range of projects as part of the accompanying research into the possible impacts of offshore wind turbines on the marine environment. These include the ANKER project "Approaches to cost reduction in the collection of monitoring data for offshore wind farms", the R&D study BeMo "Assessment approaches for underwater sound monitoring in the context of offshore licensing procedures, spatial planning and MSFD", and various sub-projects within the NavES R&D network "Nature-compatible developments at sea". The results from the ongoing BSH projects will flow directly into the further development of standards and norms, such as the development of the StUK5.

The pooling of information creates an increasingly solid basis for impact forecasting. The research projects serve the continuous further development of a uniform quality-checked basis of marine environmental information for the assessment of possible impacts of offshore installations and form an important basis for the updating of the FEP.

11.9 Overall plan assessment

In summary, with regard to the specifications of the maritime spatial plan, the effects on the marine environment are minimised as far as possible through orderly, coordinated overall planning. The safeguarding of the nature conservation areas designated by ordinance as priority areas for nature conservation serves to protect the conservation purposes and to safeguard open space. The designation of the main diver concentration area, which is larger in terms of area, as a priority area encompassing sub-area II of the "Sylt Outer Reef - Eastern German Bight" nature conservation area can also have a positive impact on other species protected in the nature conservation area or bird sanctuary and their feeding and resting grounds, and takes account of the protection of the diver species group, which is sensitive to disturbance, and its particularly important habitat in the North Sea EEZ. Since other uses (military use, sand and gravel extraction) are to interfere as little as possible with the conservation purpose of the priority area for common divers, and since there is to be no interference from sand and gravel extraction or agreement on military use in the period from 1 March to 15 May of any given year, the protection of common divers is additionally emphasised.

In addition, the exclusion of turbines above the water surface from the definition 2.4 (4) serves to ensure the implementation of measures to safeguard the coherence of the Natura 2000 network (coherence measures) with regard to impairments caused by existing wind turbines in the priority or reserved area for divers. In order to enable nature conservation planning to develop its own compensation scheme in this respect, the temporary designation 2.4 (4) is made as spatial planning support, which temporarily protects the area in question from conflicting uses. This also supports the protection of divers.

Based on the current state of knowledge, it must be assumed that the wind farm projects to be realised on EN13 will have an impact on the priority area divers to the extent identified and that it will therefore be necessary to examine in the individual procedure the extent to which avoidance and mitigation measures must be used for the specific turbines applied for. However, in the overall view, the positive effects outweigh the negative effects due to the designation of the main concentration area as a priority area for divers beyond the "Sylt Outer Reef - Eastern German Bight" conservation area established by ordinance and due to the aforementioned stipulations on the consideration of conservation purposes. The designation of the reserved areas for divers (StN1 to StN3) simultaneously takes into account the sustainable use of the reserved areas EN4 and EN5.

The reserved areas for power lines run predominantly outside ecologically significant areas. Subject to strict compliance with avoidance and mitigation measures, significant impacts can be avoided, in particular through the implementation of the designations for offshore wind energy and power lines.

On the basis of the above descriptions and assessments, as well as the assessment of species and site protection, it must be concluded for the Strategic Environmental Assessment, also with regard to any interactions, that, according to current knowledge and at the comparatively abstract level of spatial planning, no significant impacts on the marine environment within the study area are to be expected as a result of the planned specifications.

Most of the environmental impacts of the individual uses for which specifications are made would also occur - based on the same medium-term time horizon - if the plan were not implemented, since it is not evident that the uses would not take place or would take place to a significantly lesser extent if the plan were not implemented. From this point of view, the provisions of the plan appear fundamentally "neutral" with regard to their effects on the environment. Although it is possible in principle that, due to the concentration/bundling of individual uses on certain areas/territories, some of the provisions of the plan may well have negative environmental impacts in the area of this specific area, an overall balance of the environmental impacts would tend to be positive due to the bundling effects, as the remaining areas/territories are relieved and hazards to the marine environment (e.g. collision risk) are reduced.

For certain specifications in the area north of the shipping route SN10, detailed data and findings are lacking for individual protected goods. Therefore, the forecasts of the SEA for these specifications require a more detailed review in the context of downstream planning stages.

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