BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE

Environmental Report on the Spatial Plan for the German Exclusive Economic Zone in the North Sea

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List of abbreviations

AC	Alternating current
AIS	Automatic Identification System (for ships)
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas
AWI	Alfred Wegener Institute for Polar and Marine Research
EEZ	Exclusive Economic Zone
BBergG	Federal Mining Act
BfN	Federal Agency for Nature Conservation
BFO	Federal Offshore Grid Plan
BFO-N	Federal Offshore Grid Plan North Sea
BFO-O	Federal Offshore Grid Plan Baltic Sea
BGBl	Federal Law Gazette
BMI	Federal Ministry of the Interior, Building and Community
BMUB	Federal Ministry for the Environment, Nature Conservation, Construction and Nuclear Safety
BNatSchG	Act on Nature Conservation and Landscape Management (Federal Nature Conservation Act)
BNetzA	Bundesnetzagentur (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
DC	Direct current (DC)
EMSON	Survey of marine mammals and seabirds in the German EEZ of the North Sea and Baltic Sea
EUNIS	European Nature Information System
R&D	Research and development
FEP	Site development plan
FFH	Flora Fauna Habitat
FFH Directive	Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (Habitats Directive)
FFH-VP	Impact assessment in accordance with Article 6, paragraph 3 FFH Directive and Section 34 BNatSchG
FPN	North Sea Research Platform
HELCOM	Helsinki Convention
IBA	Important bird area
ICES	International Council for the Exploration of the Sea
IfAÖ	Institute for Applied Ecosystem Research
IOW	Leibniz Institute for Baltic Sea Research, Warnemünde
IUCN	International Union for Conservation of Nature and Natural Resources
K	Kelvin
LRT	Habitat type under the Habitats Directive
MARPOL	International Convention for the Prevention of Pollution from Ships

MINOS	Marine warm-blooded animals in the North Sea and Baltic Sea: Foundations for assessment of offshore wind turbines
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 Null [Seal Level]
OSPAR	Oslo-Paris Agreement
OWF	Offshore wind farm
PAH	Polycyclic aromatic hydrocarbons
POD	Porpoise Click Detector
PSU	Practical Salinity Units
ROP	Martime spatial plan
ROP 2009	Maritime spatial plan for the German EEZ 2009
SCANS	Small Cetacean Abundance in the North Sea and Adjacent Waters
SeeAnlV	Ordinance on Installations on the seaward side of the German territorial sea (Offshore Installations Ordinance)
SEL	Sound event level
SPA	Special Protected Area
SPEC	Species of European Conservation Concern
StUK4	Standard "Investigation of the impacts of offshore wind turbines"
StUKplus	"Accompanying ecological research on the alpha ventus offshore test field project"
SEA	Strategic environmental assessment
SEA Directive	Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the environmental impacts of certain plans and programmes (SEA Directive)
UBA	Umweltbundesamt (Federal Environment Agency)
TSO	Transmission system operator
UVPG	Environmental Impact Assessment Act
EIA	Environmental impact assessment
EIS	Environmental impact study
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)
WTG	Wind turbine
WHG	Federal Water Act
WindSeeG	Offshore Wind Energy 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] . In accordance with Section 17, paragraph 1 ROG, the competent Federal Ministry, the Federal Ministry of the Interior, (BMI), shall draw up a spatial plan for the German EEZ as a statutory instrument in agreement with the federal ministries concerned. In accordance with Section 17, paragraph 1, sentence 3 ROG, the BSH, with the approval of the BMI, carries out the preparatory procedural steps for the preparation of the spatial plan (ROP). During the preparation of the ROP, an environmental assessment is carried out according to the provisions of the ROG and, where applicable, those of the Environmental Impact Assessment Act (UVPG)[2], the Strategic Environmental Assessment (SEA).

The obligation to implementation a strategic environmental assessment, including the preparation of an environmental report, arises for the update, amendment, and revocation of the existing spatial plans from 2009 from Section 7, paragraph 7, 8 ROG in conjunction with Section 35, paragraph 1, No. 1 UVPG in conjunction with No. 1.6 of Annex 5.

According to Article 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 consideration in the preparation and adoption of plans well in advance of actual project planning. According to Section 8 ROG, the Strategic Environmental Assessment has the task of identifying the likely significant impacts of implementing the plan and describing and assessing them in an environmental report at an early stage. It serves as an effective environmental precaution according to the applicable laws and is implemented according to consistent principles, and with public participation. All factors under section 8 subsection 1 of the ROG are to be considered:

- Human beings, including human health,
- Animals, plants, and biodiversity,
- Land, seabed, water, air, climate, and landscape,
- Cultural assets and other material assets as well as
- Interrelationships between the aforementioned protected assets.

Within the framework of spatial planning, designations are mainly made in the form of priority and reservation 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 Section 8, paragraph 1 ROG.

Accordingly, the environmental report consists of an introduction, a description, and an assessment of the environmental impacts identified in the environmental assessment according to Section 8, paragraph 1 ROG as well as additional information.

According to No. 2d) of Annex 1 to Section 8 ROG, other planning options that expressly come into consideration should also be named,

[1] Of 22 December 2008 (BGBl. I p. 2986, last amended by Article 159 of the ordinance of 19 June 2020 BGBl. I p. 1328).

[2] In the version of the announcement from 24 February 2010, BGBl. I p. 94, last amended by Article 2 of the Act of 30 November 2016 (BGBl. I p. 2749).

taking into consideration the objectives and the spatial scope of the ROP.

1.2 Brief description of the content and main objectives of the Site Development Plan

According to Section 17, paragraph 1 ROG, the spatial plan for the German EEZ is to make designations taking into consideration any interrelationships between land and sea as well as safety aspects:

1. for ensuring the safety and ease of movement of shipping traffic,
2. For further economical uses,
3. for scientific uses and
4. to protect and enhance the marine environment.

According to Section 7, paragraph 1 ROG, the spatial plan for a specific planning area and a regular medium-term period must contain designations as **objectives and principles** of spatial planning for the development, order, and safeguarding of the area, in particular for the uses and functions of the area.

According to Section 7, paragraph 3 ROG, these designations may also designate areas. For the EEZ, these can be the following areas:

Priority areas intended for certain spatially significant functions or uses and excluding other spatially significant functions or uses in the area, where these are incompatible with the priority functions or uses.

Reservation areas 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.

Suitability areas for the marine area in which certain spatially significant functions or uses do not conflict with other spatially significant interests, whereby 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 according to Section 7, paragraph 3, sentence 2, No. 4 ROG.

According to Section 7, paragraph 4 ROG, the spatial plans shall also contain those designations on spatially significant plans and measures by public bodies and persons under private law according to Section 4, paragraph 1, sentence 2 ROG that are suitable for inclusion in spatial plans and necessary for the coordination of spatial claims and which can be secured by objectives or principles of spatial planning.

1.3 Relationship with other relevant plans, programmes and projects

In Germany there is a tiered planning system of spatial planning by the Federal Spatial Planning Act (Bundesraumordnung) as well as by state and regional planning to coordinate all spatial requirements and concerns arising in a given area. According to section 1 subsection 1 sentence 2 of the ROG, this system is used to coordinate different spatial requirements in order to reconcile conflicts arising at the respective planning level and to make rules for individual uses and functions of the space.

The tiered system allows the planning to be further specified by the subsequent planning levels. According to Section 1, paragraph 3 ROG, the development, organisation, and safeguarding of the sub-areas should fit into the circumstances and requirements of the overall area. The development, organisation, and safeguarding of the overall area should also take into consideration the circumstances and requirements of its sub-areas.

The Federal Ministry of the Interior, Building and Community is responsible for regional planning at the federal level in the EEZ. On the other hand, the respective federal state is responsible for the entire area of the state, including the respective territorial waters.

In addition to spatial planning for the respective areas of responsibility, there are sectoral plans based on 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 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 advisable and must be taken into account in the cumulative assessment of impacts on the marine environment. The regional planning for both Lower Saxony and Schleswig-Holstein is currently being updated. Regional spatial planning programmes of the coastal regions are taken into consideration insofar as significant designations for the territorial waters are made.

1.3.1.1 Lower Saxony

The spatial plan for the state of Lower Saxony, including the Lower Saxony territorial waters, constitutes the State Spatial Planning Programme (LROP). The Ministry of Food, Agriculture and Consumer Protection of Lower Saxony, as the highest state planning authority, is responsible for drawing up and amending it; the final decision on the LROP is the responsibility of the state government. The LROP is based on a directive from 1994 and has been updated several times since then, most recently in 2017. At the end of 2019, the procedure for a new update was initiated.

1.3.1.2 Schleswig-Holstein

In Schleswig-Holstein, the State Development Plan (LEP S-H) is the basis for the state's spatial development. The Ministry of the Interior, Rural Areas, Integration and Equality of the Federal State of Schleswig-Holstein (MILIG) is responsible for its establishment and amendment. The current LEP S-H 2010 is the basis for the spatial development of the state until 2025. The state 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 and is currently preparing the planning phase. The plan is binding and covers a planning area.

1.3.1.4 United Kingdom

England consists of 11 planning areas and each area is to receive its own plan. These are to be designed for the long term of about 20 years and reviewed and reported on every three years and updated if necessary.

The East Inshore and East Offshore Marine Plans were adopted in 2014. The draft North East Inshore and Offshore Marine Plan was published for consultation in January 2020. The English North East, North West, South East, and South West Marine Plans were adopted and published in June 2021. 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. The consultation on the revision of the first plan has just been completed. Scotland has one national maritime spatial plan and 11 spatial planning areas. The spatial plans are also binding in Scotland.

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; this will be binding and cover a timeframe until 2050.

1.3.2 MSFD programme of measures

Each Member State has to develop a marine strategy to achieve good status for its marine waters; in Germany, for the North Sea and the Baltic Sea. Essential here is the establishment of a programme of measures to achieve or maintain good environmental status as well as 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). The current MSRL programme of measures mentions maritime spatial planning under Objective 2.4 “Seas with sustainably and sparingly used resources” as a contribution of existing measures to the achievement of the operational objectives of the MSFD. The catalogue of measures also formulates a concrete review mandate for the update of 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 according to Section 7, paragraph 3 Ordinance on the Establishment of the “Borkum Riffgrund” nature conservation area (NSGBRgV)[3], Section 7, paragraph 3 Ordinance on the Establishment of the “Doggerbank” nature conservation area (NSGDgbV)[4], and Section 9, paragraph 3 Ordinance on the Establishment of the “Sylter Außenriff – Östliche Deutsche Bucht” nature conservation area (NSGSylV)[5] on the management plans for nature conservation areas in the German EEZ of the North Sea. On 13 May 2020, the management plans "Borkum Riffgrund"[6], "Doggerbank"[7] and "Sylt Outer Reef - Eastern German Bight"[8] were published in the Federal Gazette.

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

For the area of the German EEZ, a multi-stage planning and approval process (i.e. a division 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 spatial plan is the forward-looking planning instrument that coordinates a wide variety of utilisation interests in the fields of economy, science, and research as well as protection claims. A strategic environmental assessment must be carried out when drawing up the spatial plan. The SEA for the ROP is related to various downstream environmental assessments, in particular the directly downstream SEA for the site development plan (SDP).

The next stage is the SDP. Within the framework of the central model, the SDP is the control instrument for the orderly expansion of offshore wind energy and power grids in a phased planning process. The SDP has the character of sectoral planning. The sectoral plan is designed to plan the use of offshore wind energy and the power grids in a targeted manner and as optimally as possible under the given framework conditions – in particular the requirements of spatial planning – by designating areas and sites as well as locations, routes and route corridors for grid connections and for cross-border

[3] Of 22 September 2017 (BGBl. I p. 3395).

[4] “Dated 22 September 2017 (BGBl. I p. 3400).

[5] Of 22 September 2017 (BGBl. I p. 3423).

[6] Published on 17 April 2020, BAnz AT 13 May 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.

submarine cable systems. As a matter of principle, a strategic environmental assessment is carried out to accompany the preparation, update, and amendment of the SDP.

In the next step, the sites for offshore wind turbines defined in the SDP are pre-examined. If the prerequisites of Section 12, paragraph 2 WindSeeG are met, the site investigation is followed by a determination of the suitability of the site for the construction and operation of offshore wind turbines. A Strategic Environmental Assessment will also be carried out to accompany the site investigation.

If the suitability of a site for the use of offshore wind energy is determined, the site is put out to tender and the winning bidder or the correspondingly entitled party can submit an application for approval (planning approval) for construction and operation of wind turbines at the site specified in the SDP. As part of the planning approval procedure, an environmental impact assessment is carried out if the prerequisites are met.

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

According to Section 1, paragraph 4 UVPG, the UVPG also applies if federal or state legislation does not specify the environmental impact assessment in more detail or does not comply with the essential requirements of the UVPG.

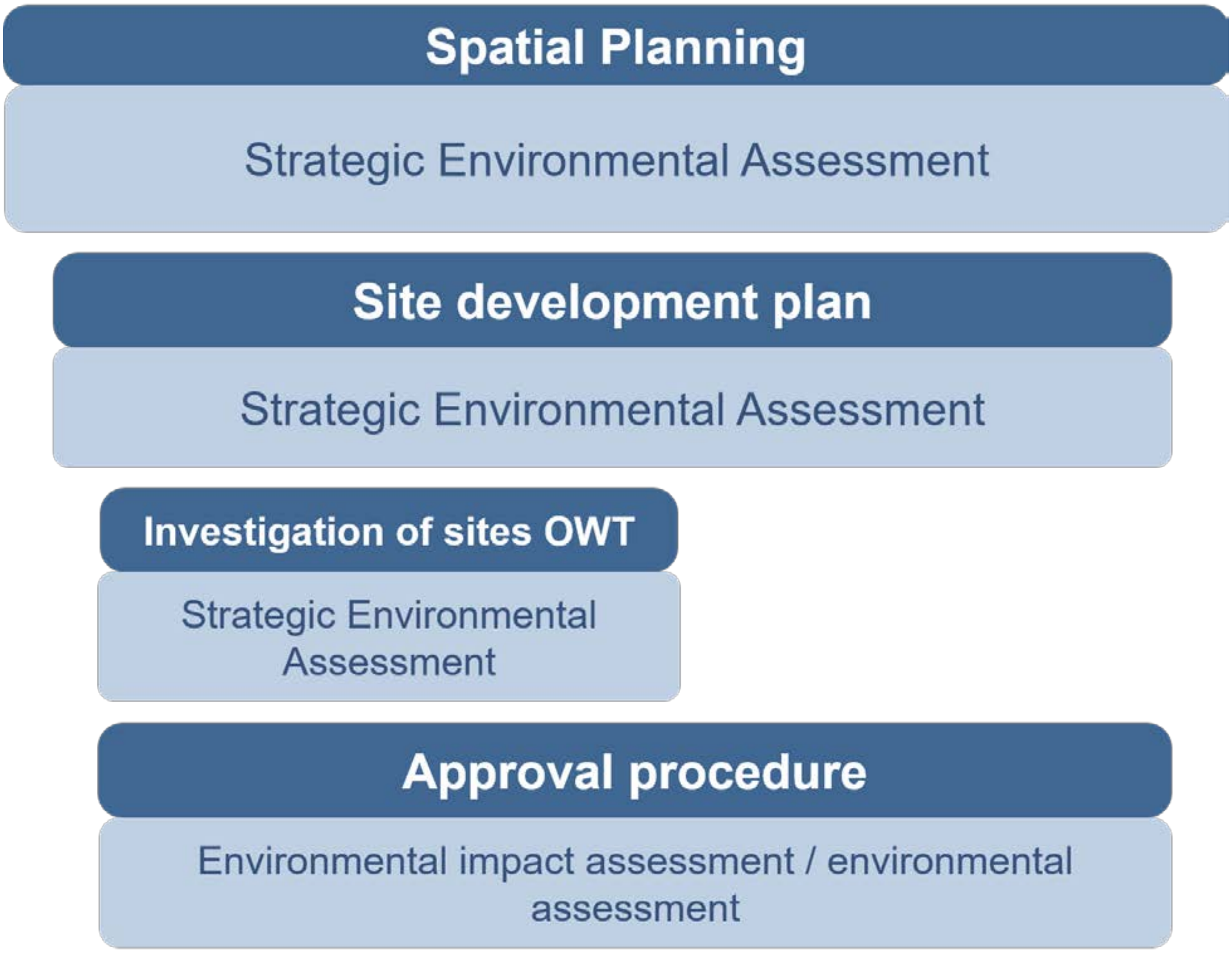


Figure 1: Overview of the staged planning and approval process in the EEZ.

In the case of multi-stage planning and approval procedures, it follows from the relevant legislation (e.g. Spatial Planning Act, WindSeeG and BBergG) or, more generally, from Section 39, paragraph 3 UVPG that, in the case of plans, it should be designated at the stage of defining the scope of investigation at which certain environmental impacts are to be assessed in particular. In this way, multiple audits are to be avoided. The nature and extent of the environmental impacts, technical requirements, and the content and subject matter of the plan shall be taken into consideration.

In the case of subsequent plans as well as subsequent approvals of projects for which the plan sets a framework, the environmental assessment according to Section 39, paragraph 3, sentence 3 UVPG shall be limited to additional or other significant environmental impacts as well as to necessary updates and deepening.

Within the framework of the staged planning and approval procedure, all reviews have in common that environmental impacts on the protected assets listed in Section 8, paragraph 1 ROG and Section 2, paragraph 1 UVGP are considered, including their interrelationships.

According to the definition of Section 2, paragraph 2 UVPG, environmental impacts within the meaning of the UVPG are direct and indirect impacts of a project or the implementation of a plan or programme on the protected assets.

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

In the offshore area, the special protected assets avifauna have emerged as subcategories of the legally specified protected assets animals, plants, and biological diversity: Seabirds/resting birds and migratory birds, benthos, biotopes, plankton, marine mammals, fish and bats.

Figure 2: Overview of the protected assets 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 plan on behalf of the responsible Federal Ministry; which comes into force in the form of a legal ordinance.

Taking into consideration any interrelationships between land and sea as well as safety aspects, the spatial plans shall **designate**

- for ensuring the safety and ease of movement of shipping traffic,
- for further economic uses,

- for scientific uses and
- to protect and improve the marine environment.

Within the framework of spatial planning, designations are mainly made in the form of priority and reservation areas as well as other objectives and principles. According to Section 8, paragraph 1 ROG, a strategic environmental assessment must be carried out by the body responsible for the spatial plan when drawing up spatial plans; as part of this, the likely significant impacts of the respective spatial plan on the protected assets, including interrelationships, are to be identified, described, and assessed.

The **objective** of the spatial planning instrument is to optimise overall planning solutions. A wider spectrum of uses and functions is considered. Fundamental strategic questions should be clarified at the beginning of a planning process. 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.

In principle, the **depth of assessment** in the spatial planning is 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 effects 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 Site development plan

The next stage is the SDP.

The **designations** to be made by the SDP and examined within the framework of the SEA are derived from Section 5, paragraph 1 WindSeeG. The plan mainly designates areas and sites for wind turbines as well as the expected power to be installed on the sites. In addition, the SDP designates routes, route corridors, and locations. Planning and technical principles are also laid down. Although these also serve, among other things, to reduce environmental impacts, they may in turn lead to impacts, so that an assessment is required as part of the SEA.

With regard to the SDP's **objectives,** 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 the need, purpose, technology and the identification of sites and routes or route corridors. The plan therefore primarily has the function of a management planning instrument in order to create a spatially and, as far as possible, environmentally compatible framework for the implementation of individual projects, i.e. the construction and operation of offshore wind turbines, their grid connections, interconnectors and cross-connections between converter/transformer platforms.

The **depth of the examination** 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. At the level of sectoral planning, detailed analyses are generally not yet performed. Above all, local, national, and global impacts as well as secondary, cumulative, and synergetic impacts are taken into consideration in the sense of an overall view.

As with the instrument of maritime spatial planning, the **focus** of the assessment is on possible cumulative effects as well as possible cross-border impacts. In addition, the SDP focuses on the strategic, technical, and spatial alternatives for the use of wind energy and power cables.

1.3.4.3 Suitability assessment as part of the site investigation

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

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

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

Both the criteria of Section 5, paragraph 3 WindSeeG and the concerns of Section 48, paragraph 4, sentence 1 WindSeeG require an assessment of whether the marine environment is threatened. With regard to the latter concerns, it shall be verified in particular that there is no risk of pollution of the marine environment within the meaning of Article 1, paragraph 1, number 4 of the United Nations Convention on the Law of the Sea and that bird migration is not threatened.

The site investigation with the suitability assessment or determination is thus the instrument interposed between the SDP and the planning approval for offshore wind turbines. It refers to a specific site designated in the SDP and is thus much more small-scale than the SDP. It is distinguished from the planning approval procedure by the fact that a testing approach that is independent of the subsequent specific type of installation and layout is to be applied. Thus, the impact forecasting is based on model-like parameters (e.g. in two scenarios or in ranges), which are intended to depict possible realistic developments.

Compared with the SDP, the SEA of the suitability assessment is thus characterised by a smaller area of investigation 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 a site on the one hand and the determination of its (possibly also partial) unsuitability (see Section 12, paragraph 6 WindSeeG) on the other. Restrictions on the type and extent of development, which are included as specifications 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 procedure (planning approval and planning authorisation procedure) for offshore wind turbines

The next stage after the site investigation is the approval procedure for the construction and operation of offshore wind turbines. After the pre-investigated site has been put out to tender by the BNetzA, the winning bidder can submit an application for planning approval or – if the prerequisites are met – for planning approval for the construction and operation of offshore wind turbines, including the necessary ancillary installations on the pre-investigated site with the award of the contract to the BNetzA in accordance with Section 46, paragraph 1 WindSeeG.

In addition to the legal requirements of Section 73, paragraph 1, sentence 2 VwVfG, the plan must include the information contained in Section 47, paragraph 1 WindSeeG. The plan may be adopted only under certain conditions listed in Section 48, paragraph 4 WindSeeG and, among other things, only if the marine environment is not threatened, in particular if there is no concern of pollution of the marine environment within the meaning of Article 1, paragraph 1, Number 4 of the Convention on the Law of the Sea and bird migration is not threatened.

According to Section 24 UVPG, the competent authority shall prepare a summary presentation

- of the environmental impacts of the project,
- the characteristics of the project and the location that are intended to exclude, mitigate, or compensate for significant negative environmental impacts,
- of the measures to exclude, mitigate, or compensate for significant adverse environmental impacts, and
- of the compensatory measures in the case of interventions in nature and landscape.

According to Section 16, paragraph 1 UVPG, the project developer must submit a report to the competent authority on the likely environmental impacts of the project (EIA report), which must contain at least the following information:

- a description of the project, including the location, nature, scope, 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 location that are intended to exclude, mitigate, or compensate for the occurrence of significant adverse environmental impacts of the project,
- a description of the planned measures to exclude, mitigate, or compensate for the occurrence of significant adverse environmental impacts of the project and a description of planned compensatory measures,
- a description of the expected significant environmental impacts of the project,
- a description of the reasonable alternatives relevant to the project and its specific characteristics that have been considered by the project developer and an indication of the main reasons for the choice made, taking into consideration the environmental impacts 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 at upstream stages.

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

In the phased planning process, the installation and operation of grid connections for offshore wind turbines (converter platform and submarine cable systems, if applicable) is examined at the level of the approval procedures (planning approval and planning authorisation procedures) in implementation of the requirements of spatial planning and the designations of the SDP at the request of the respective project developer – the responsible TSO.

According to Section 44, paragraph 1 in conjunction with Section 45, paragraph 1 WindSeeG, the construction and operation of installations for the transmission of electricity require planning approval. In addition to the legal requirements of Section 73, paragraph 1, sentence 2 VwVfG, the plan must include the information contained in Section 47, paragraph 1

WindSeeG. The plan may be adopted only under certain conditions listed in Section 48, paragraph 4 WindSeeG and, among other things, only if the marine environment is not threatened, in particular if there is no concern of pollution of the marine environment within the meaning of Article 1, paragraph 1, Number 4 of the Convention on the Law of the Sea and bird migration is not threatened.

In all other respects, the requirements for the environmental assessment of offshore wind turbines, including ancillary installations, shall apply mutatis mutandis to the implementation of the environmental impact assessment according to Section 1, paragraph 4 UVPG.

1.3.4.6 Cross-border submarine cable systems

According to Section 133, paragraph 1 in conjunction with paragraph 4 BBergG , the installation 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).

According to Section 133, paragraph 2 BBergG, the aforementioned permits may be refused if there is a threat to the life or health of persons or to material assets or an adverse effect of overriding public interests that cannot be prevented or compensated for by a time limit, conditions, or requirements. An adverse effect of overriding public interests shall be deemed to exist in particular in the cases specified in Section 132, paragraph 2, No. 3 BBergG. According to Section 132, paragraph 2 No. 3 b) and d) BBergG, an adverse effect of overriding public interests with regard to the marine environment exists in particular if the flora and fauna would be adversely affected or if there is a risk of pollution of the sea.

According to Section 1, paragraph 4 UVPG, the essential requirements of the UVPG must be observed for the installation and operation of transboundary submarine cable systems.

Tabular overview of environmental audits: Focus of the investigations

Spatial planning **SEA**	**FEP** **SEA**	**Preliminary study** **SEA suitability test**	**Approval procedures** **(Planning approval or planning authorisation) grid connections** **EA**	**Approval procedures** **Cross-border submarine cable systems** **EA**
Strategic planning for designations	**Strategic planning for designations**	**Strategic determination of suitability for sites with WT**	**Environmental assessment Request for**	**Environmental assessment Request for**
designations and subject of assessment*				
Priority and reservation areas • for ensuring the safety and ease of movement of shipping traffic, • To further economic uses. especially offshore wind energy and pipelines • for scientific uses and Protection and improvement of the marine environment Objectives and principles Application of the ecosystem approach	• Areas for offshore wind turbines • Sites for offshore wind turbines, including the expected power* to be installed • Platform locations • 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 connecting cables* • according to the requirements of spatial planning and the site development plan	• the construction and operation of cross-border submarine cable systems • according to the requirements of spatial planning and the SDP
Analysis of environmental impacts				
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 impacts of the plan on the marine environment.	Analyses (determines, describes and evaluates) the likely significant environmental impacts of the construction and operation of wind turbines, which can be assessed independently of the later design of the project, on the basis of model assumptions	Analyses (identifies, describes, and assesses) the environmental impacts of the specific project (platform and connecting cable, if applicable).	Analyses (identifies, describes, and assesses) the environmental impacts of the specific project.
Target				
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, addresses the fundamental questions of • Need or legal objectives • Purpose	For the use of wind turbines, deals with the fundamental questions by • Capacity	Deals with questions regarding the concrete design ("how") of a project (technical equipment, construction - building permits).	Deals with questions regarding the concrete design ("how") of a project (technical equipment, construction - building permits).

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).	• Technology • Capacities • Finding locations for platforms and routes. Searches for environmentally sound bundles of measures without making an absolute assessment of the environmental impact of the planning.	• Suitability of the site Provides the information on the site regulated by law for the submission of tenders. Searches for environmentally sound bundles of measures without assessing the environmental impact of the specific project.	Assesses the environmental impact of the project and formulates conditions.	Assesses the environmental impact of the project and also formulates conditions.
Essentially functions as a steering planning instrument for the planning authorities in order to create an environmentally sound framework for all uses.	Acts mainly as a steering planning instrument to create an environmentally sound framework for the realisation of individual projects (wind turbines and grid connections, transboundary submarine cables)	Acts as an instrument between the SDP and the approval procedure for wind turbines on a specific site.	Functions primarily as a passive review tool that responds to the developer's request.	Functions primarily as a passive revie[w] tool that responds to the developer's r[e]quest.

Assessment depth

Characterised by greater breadth of investigation (i.e. a larger number of alternatives and less depth of investigation (no detailed analyses)) Spatial, national, and global impacts as well as secondary, cumulative, and synergetic impacts are taken into consideration in the sense of an overall view.	Characterised by greater breadth of investigation (i.e. a larger number of alternatives and less depth of investigation (no detailed analyses)) Local, national, and global impacts as well as secondary, cumulative, and synergetic impacts are taken into consideration in the sense of an overall view.	Characterised by a smaller area of investigation, greater depth of investigation (detailed analyses). The determination of suitability may include specifications for the subsequent project, in particular with regard to the type and extent of the development of the site and its location.	Characterised by narrower area of investigation (limited number of alternatives) and greater depth of investigation (detailed analyses). Assesses the environmental impact of the project and formulates conditions. Primarily considers local impacts in the vicinity of the project.	Characterised by narrower area 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 assessment

Cumulative effects Overall plan view Strategic and large-scale alternatives Possible cross-border impacts	**Cumulative effects** Overall plan view Strategic, technical, and spatial alternatives Possible cross-border impacts	**Local effects in** relation to the site and its location.	Installation, construction, and operational environmental impacts Dismantling of the installation Testing in relation to the specific installation design. Intervention and compensatory measures.	Environmental impacts of turbines, construction and operation Testing in relation to the specific installation design. Intervention and compensatory measures.

Approval procedure (planning approval or planning authorisation) for WT

EIA

Subject of the assessment

Assessment of the environmental impact on application for

- the construction and operation of wind turbines
- on the area defined and investigated in the SDP
- According to the designations of the SDP and specifications of the site investigation.

Environmental impact assessment

Analyses (determines, describes and evaluates) the environmental impacts of the specific project (wind turbines, platforms and internal cabling of the wind farm, if applicable)

According to Section 24 UVPG, the competent authority shall prepare a summary presentation

- of the environmental impacts of the project,
- Of the characteristics of the project and of the site, which are intended to prevent, reduce or offset **significant adverse environmental effects,**
- of the measures to exclude, mitigate, or compensate for significant adverse environmental impacts, and
- of the compensatory measures in the case of interventions in nature and landscape (remark: Exception according to Section 56, paragraph 3 BNatSchG

Target

Addresses the questions of the specific design ("how") of a project (technical equipment, construction).

Serves primarily as a passive assessment instrument that reacts to requests from the tender winner/project developer.

Assessment depth

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

Assesses the environmental compatibility of the project on the site under study and formulates conditions for this.

Considers mainly local effects in the vicinity of the project.

Focus of the assessment

The main focus of the assessment is formed by:

- Environmental impacts from construction and operation.
- Testing in relation to the specific installation design.
- Dismantling of the installation.

Figure 3: Overview of the priorities of environmental assessments in the planning and approval procedure

1.3.5 Lines

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

According to Section 8, paragraph 1 ROG, the likely significant impacts of the designations on pipelines on the protected assets must be identified, described, and assessed.

According to section 133 subsection 1 in conjunction with subsection 4 of the BBergG, the construction and operation of a transit pipeline or 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).

According to Section 133, paragraph 2 BBergG, the aforementioned permits may be refused if there is a threat to the life or health of persons or to material assets or an adverse effect of overriding public interests that cannot be prevented or compensated for by a time limit, conditions, or requirements. An adverse effect of overriding public interests shall be deemed to exist in particular in the cases specified in Section 132, paragraph 2, No. 3 BBergG. According to Section 132, paragraph 2 No. 3 b) and d) BBergG, an adverse effect of overriding public interests with regard to the marine environment exists in particular if the flora and fauna would be adversely affected or if there is a risk of pollution of the sea.

According to Section 133, paragraph 2a BBergG, the construction and operation of a transit pipeline, which is also a project within the meaning of Section 1, paragraph 1, Number 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 according to the UVPG.

According to Section 1, paragraph 4 UVPG, the essential requirements of the UVPG must be observed for the installation and operation of data cables.

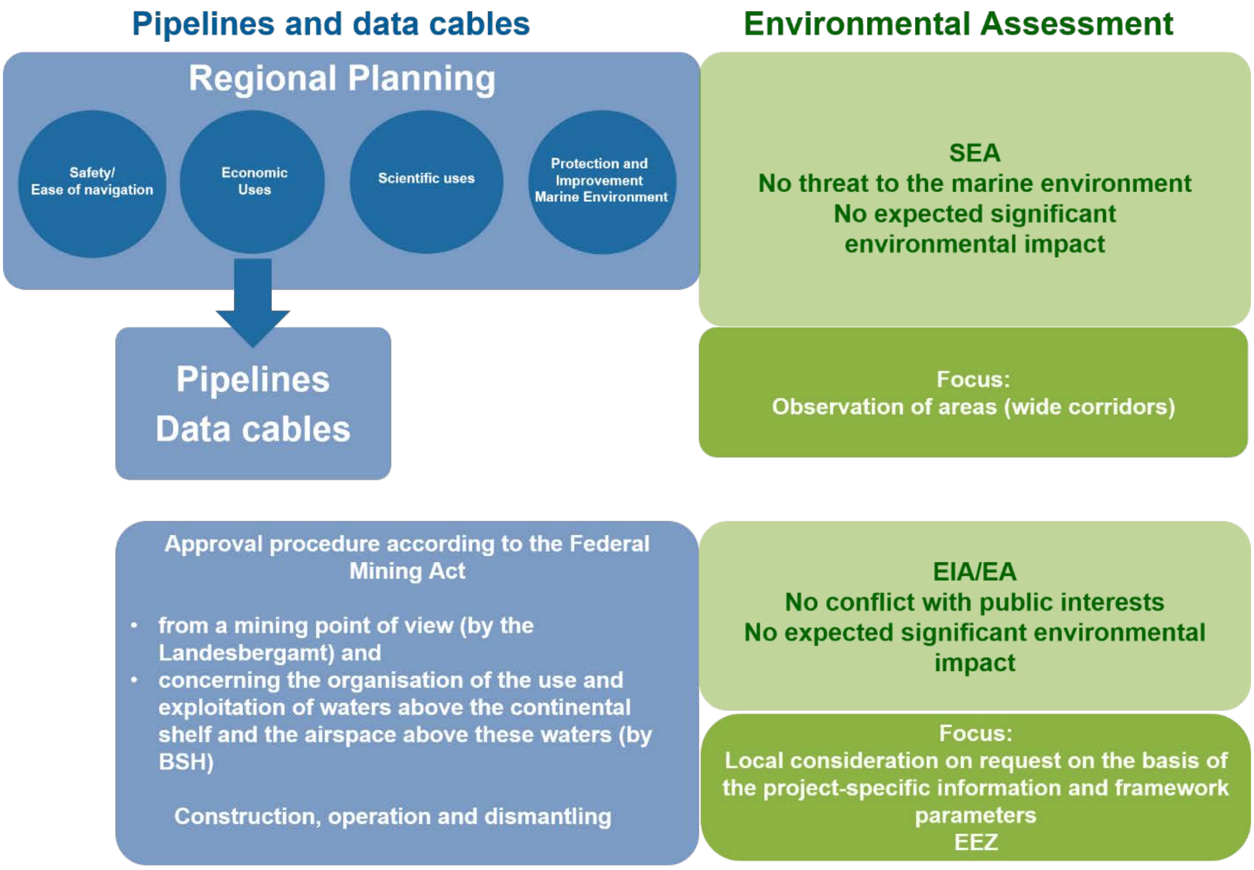


Figure 4: Overview of the focal points of the environmental assessment for pipelines and data cables.

1.3.6 Raw material extraction

In the German North and Baltic Seas, various mineral resources are sought and extracted, e.g. sand, gravel and hydrocarbons. As a superordinate instrument, spatial planning deals with possible large-scale spatial designations, possibly including other uses. The anticipated significant environmental impacts are reviewed (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 Section 4, paragraph 1 BBergG. It is carried out regularly in the marine area through geophysical investigations, including seismic surveys and exploratory drilling. In the EEZ, the extraction of raw materials includes the extraction (loosening, release), 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 specified field for a specified period of time. Additional approvals 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 shall be drawn up for a period not exceeding 2 years as a rule and shall be continuously renewed as required (Section 52, paragraph 1, sentence 1 BBergG).

In the case of mining projects requiring an UVPG, the preparation of an outline operating plan is obligatory; for the approval of this, a planning approval procedure must be carried out (Section 52, paragraph 2a BBergG). Framework operating plans are usually 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 according to Section 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 state mining offices.

1.3.7 Shipping

Within the framework of spatial planning, designations for the shipping sector are regularly made in the form of designations of areas (priority and/or reservation 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 likely significant effects of the rules 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 as concerns in the context of spatial planning. There is no tiered planning and approval process. The framework for authorised catches, fishing techniques and gear is 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 scientific research

Marine research projects can have negative impacts on the marine environment (e.g. through underwater noise generated during seismic investigations). On its website, the BfN mentions, among other things, the construction of artificial islands, installations or structures, the use of explosives, or measures of direct relevance to the exploration and exploitation of resources, which are in principle likely to have a significant effect on the area and must be assessed for their compatibility with the purpose of protecting potentially affected Natura 2000 protected areas before they are approved.

In this case, a nature conservation examination and approval are also required as part of the approval procedure. Notification is required for projects which do not require authorisation, and which may significantly affect Natura 2000 sites.

In the reserved areas, research is predominantly carried out by the Thuenen Institute under the technical supervision of the BMEL, especially within the framework of the CFP and reporting obligations within ICES. This takes place within the framework of long-term regular sampling and is not subject to authorisation in the EEZ.

1.3.10 National and allied defence

National and alliance defence is considered a concern in the context of spatial planning. There is no tiered planning and approval process.

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

1.3.11 Leisure activities

The issue of leisure is also considered. There is no tiered 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 objective of environmental protection

The establishment of the ROP and the implementation of the SEA were carried out with due consideration for the objectives of environmental protection. These provide information on the environmental status to be aimed for in the future (environmental quality objectives). The objectives of environmental protection can be found in an overview of the international, EU and national conventions and regulations dealing with marine environmental protection, 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 is checked and what specifications or measures are taken.

1.4.1 International conventions on the protection of the marine environment

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

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

- International Convention for the Prevention of Pollution from Ships, 1973 as modified 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 conventions on marine environment protection

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

1.4.1.3 Agreements specific to protected asset

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

Within the framework of the Bonn Convention, regional agreements for the conservation of the species listed in Appendix II were concluded according to Article 4, No. 3 Bonn Convention:

- Agreement on the Conservation of African-Eurasian Migratory Water Birds, 1995 (AEWA)
- Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas 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 the EU level

The relevant EU legislation to be taken into consideration is:

- Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning (MRO Directive),
- Council Directive 337/85/EEC of 27 June 1985 on the environmental impact assessment of certain public and private projects (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 the Council dated 23 October 2000 for the establishment of 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 environmental impacts of certain plans and programmes (Strategic Environmental Assessment Directive, SEA Directive),
- Directive 2008/56/EC of the European Parliament and the Council dated 17 June 2008 for the establishment of a Framework for Community Action in the field of Marine Environment (Marine Strategy Framework Directive (MSFD)),
- Council Directive 2009/147/EC on the conservation of wild birds (Birds Directive).

1.4.3 Environmental and nature conservation requirements at national level

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

- Act concerning nature conservation and landscape management (Federal Nature Conservation Act - BNatSchG)
- Federal Water Act (WHG)
- Environmental Impact Assessment Act (UVPG),
- Ordinance on the establishment of the nature conservation area “Sylter Außenriff – Östliche Deutsche Bucht”, the ordinance on the establishment of the nature conservation area “Borkum Riffgrund”, and the ordinance on the establishment of the nature conservation area “Doggerbank” in the EEZ of the North Sea,
- Management plans for nature conservation areas in the German EEZ of the North Sea,
- The energy and climate protection objectives of the federal government.

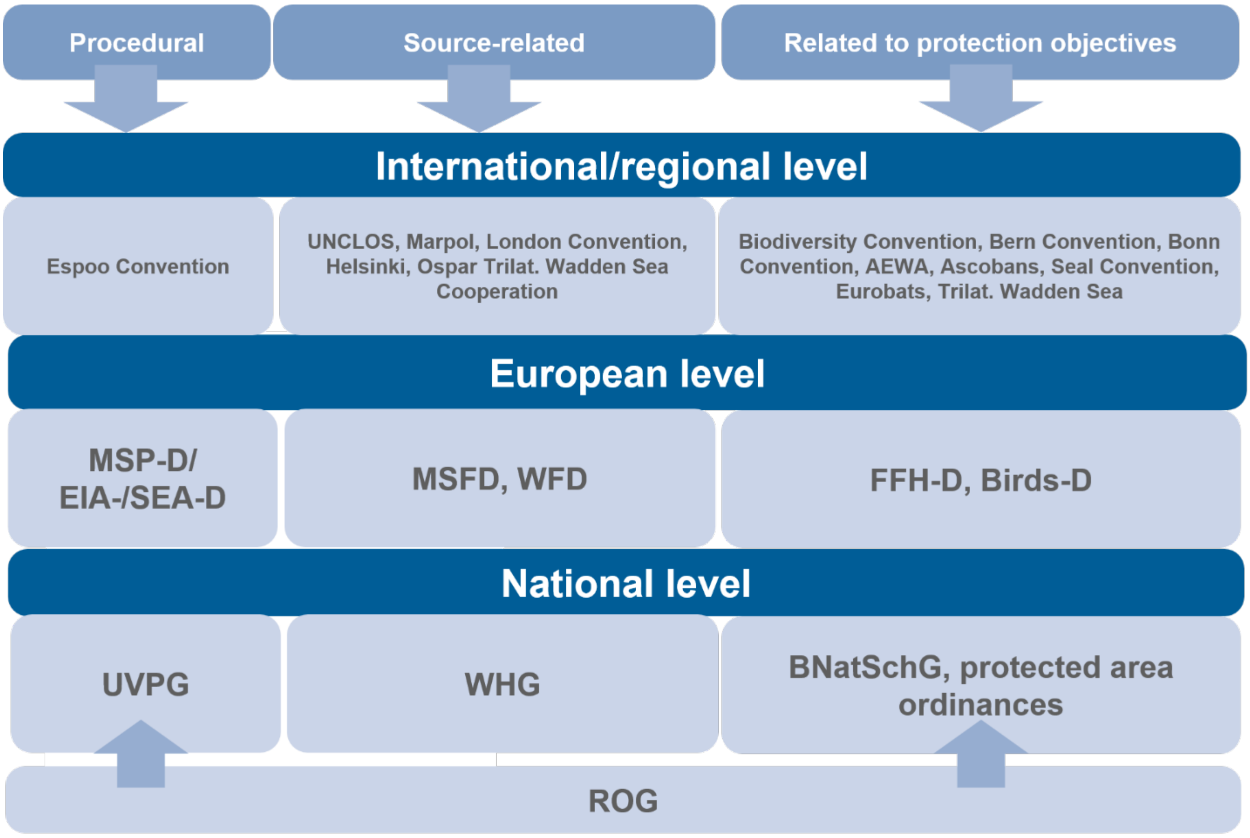


Figure 5: Overview of the normative levels of the relevant legal acts for the SEA.

1.4.4 Support for 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:

- Environmental objective 1: Marine environments free of adverse effects by human-induced eutrophication: Consideration in the objectives and principles to ensure the safety and ease of shipping traffic.
- Environmental objective 3: Seas without adverse effects on marine species and habitats as a result of the impacts of human activities: Consideration in the objectives and principles on offshore wind energy and nature conservation
- Environmental objective 6: Marine environments free of adverse effects by human-induced energy inputs: Consideration in the objectives and principles for offshore wind energy and lines

In the environmental assessment, avoidance and mitigation measures are formulated to support objectives 1, 3 and 6.

In addition, the spatial plan counteracts a deterioration of the environmental status by allowing certain uses only in spatially delimited areas and for a limited period of 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, paragraph 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 outlined in Chapter 4.3.

1.5 Methodology of the Strategic Environmental Assessment

In principle, various methodological approaches can be considered when implementing the Strategic Environmental Assessment. This environmental report builds on the methodology already used for the strategic environmental assessment of the Federal Offshore Grid Plan and the site 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, extraction of raw materials and marine research, sector-specific criteria are used to assess possible impacts.

The methodology is based primarily on the designations of the plan to be examined. Within the framework of this SEA, it is determined, described and evaluated for each of the designations whether the designations are likely to have significant impacts on the protected assets concerned. According to Section 1, paragraph 4 UVPG in conjunction with Section 40, paragraph 3 UVPG, in the environmental report the competent authority provisionally assesses the environmental impacts of the designations with regard to effective environmental precaution according to applicable laws. Criteria for the assessment can be found, among others, in Annex 2 of the Spatial Planning Act.

The object 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 rules on the use and protection of the EEZ. In each case, the assessment is carried out in relation to the protected property.

According to Article 7(1) of the ROG, spatial plans must contain provisions as spatial planning **objectives and principles** for the development, organisation and safeguarding of areas, in particular on the uses and functions of areas. According to Section 7, paragraph 3 ROG, these designations may also designate areas.

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

- Shipping
- Offshore wind energy
- Lines
- Raw material extraction
- Fisheries and marine aquaculture
- Marine research
- Nature conservation/seascape/open space
- National and allied defence

In accordance with Article 17(1) No. 4 of the ROG, provisions for the protection and improvement of the marine environment also play a role.

1.5.1 Area of investigation

The description and assessment of the state of the environment refers to the North Sea EEZ, for which the spatial plan stipulates conditions. The SUP area of investigation covers the German EEZ of the North Sea (Figure 7). It should be noted that the data situation within the EEZ of the North Sea for the area up to Shipping route 10 is significantly better than for the area northwest of Shipping route 10 because of the project-related monitoring data available.

For the area north-west of shipping route 10, the spatial plan also defines the area. Based on the available sediment data and findings from monitoring for the protected area “Doggerbank”, a description and assessment of the environmental status and an evaluation of the potential environmental impacts is also possible for this area.

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

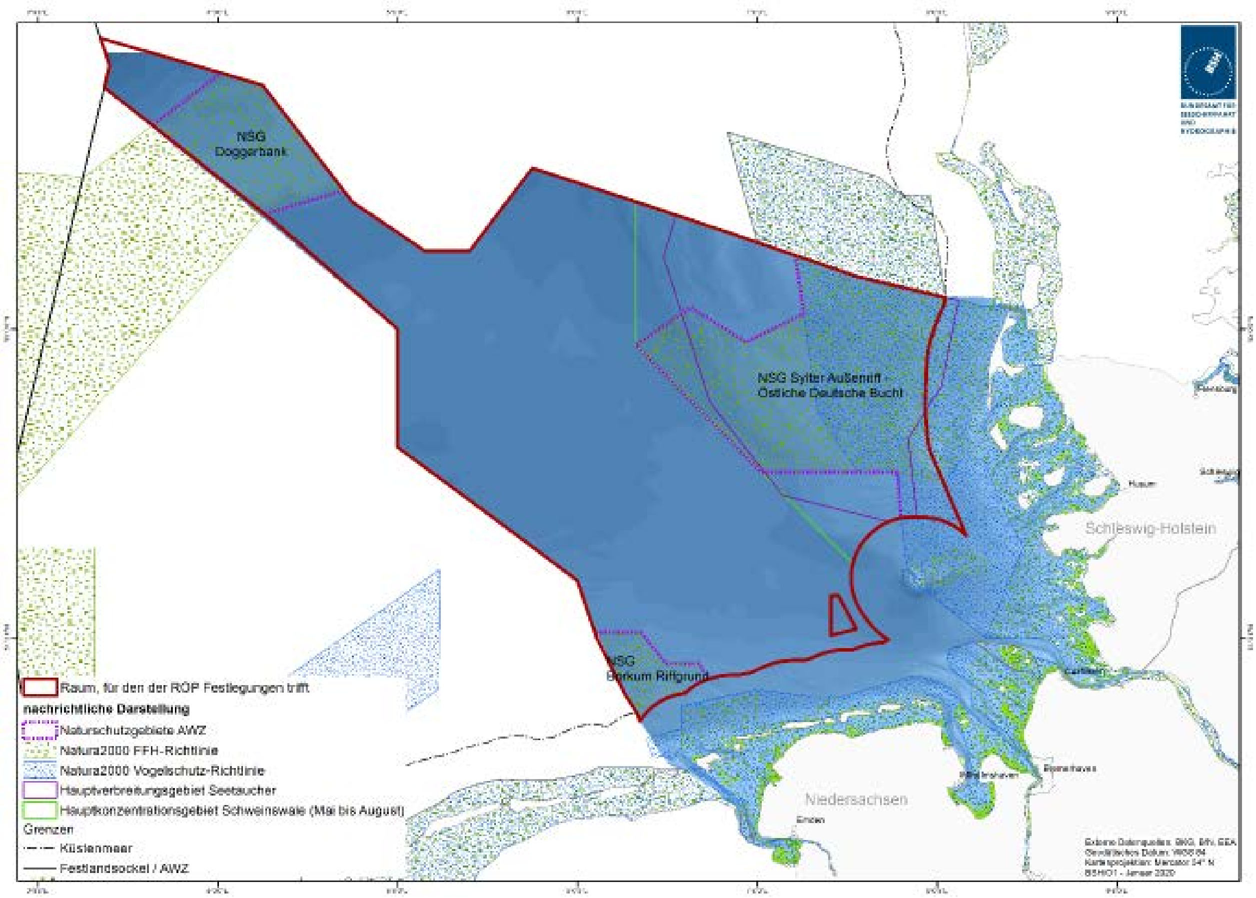


Figure 6: Delimitation of the area of investigation for the SEA (Environmental Report ROP EEZ North Sea).

1.5.2 Implementation of the environmental assessment

The assessment of the likely significant environmental impacts of the implementation of the spatial plan includes secondary, cumulative, synergistic, short-, medium- and long-term, permanent and temporary, positive and negative impacts in terms of the assets to be protected. Secondary or indirect impacts are those that are not immediate and thus may take effect only after some time and/or at other locations. Occasionally, we also speak of consequential effects or interrelationships.

Possible impacts of the implementation of the plan are described and evaluated in relation to the protected assets. A uniform definition of the term "significance" does not exist, since it is an "individually determined significance" which cannot be considered independently of the "specific characteristics of plans or programmes" (Sommer, 2005, 25f.). In general, significant impacts can be defined as effects that are serious and significant in the context being considered.

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

- “the likelihood, duration, frequency, and irreversibility of the impacts;
- the cumulative nature of the impacts;
- the transboundary nature of the impacts;
- the risks to human health or the environment (e.g. in the case of accidents);

- the magnitude and spatial extent of the impacts;
- the value and vulnerability of the area likely to be affected because of special natural characteristics or cultural heritage, the intensity of land use, and the exceeding of environmental quality standards or limit values;
- the impacts on areas or landscapes of which the protected status is recognised at national, community or international level".

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) (Appendix II SEA Directive).

In some cases, technical legislation provides further specification on when an impact reaches the materiality threshold. Sub-legislatively, threshold values have been developed in order to be able to make a delimitation.

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

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

Both permanent and temporary (e.g. construction-related) impacts are considered. This is followed by a presentation of possible interrelationships as well as a consideration of possible cumulative effects and potential transboundary impacts.

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

- Site
- Seabed
- Water
- Plankton
- Biotopes
- Benthos
- Fish
- Marine mammals
- Avifauna
- Bats
- Biological diversity
- Air
- Climate
- Landscape
- Cultural and other material resources (underwater cultural heritage)
- People, especially human health
- Interrelationships between protected assets

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

- Qualitative descriptions and evaluations
- Quantitative descriptions and assessments
- Evaluation of studies and specialist literature, reports
- 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 resulting from the rules of the plan is made on the basis of the status description and status assessment and the function and significance of the individual areas for the individual factors on the one hand, and the impacts resulting from these rules and the resulting potential impacts 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 (cf Figure 7). Further assessment criteria are the likelihood and reversibility of the impacts according to Annex 2 to Section 8, paragraph 2 ROG.

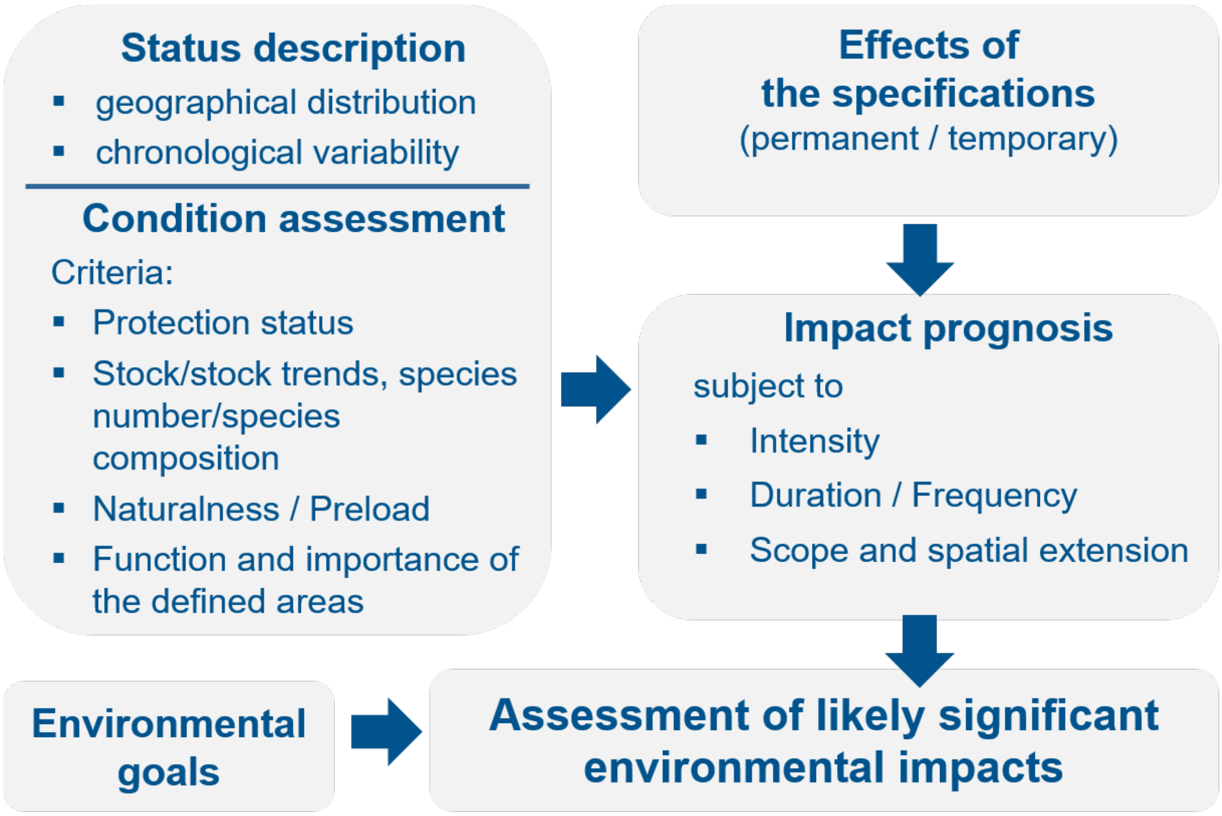


Figure 7: General methodology for assessing the likely significant environmental impacts.

1.5.3 Criteria for condition description and status assessment

The status assessment of the individual protected assets is carried out on the basis of various criteria. The assessment of the protected assets goods area/seabed, benthos and fish is based on the aspects of rarity and threat, diversity, and specificity as well as legacy impacts. The description and assessment of the protected assets marine mammals and seabirds and resting birds is based on the aspects listed in the figure. Because these are highly mobile species, it is not expedient to adopt a similar approach to the protected assets site/seabed, benthos and fish. For seabirds and resting birds and marine mammals, the criteria of protection status, assessment of occurrence, assessment of spatial units, and previous pressures are used as a basis. For the protected asset migratory birds, the aspects of rarity, threat, and legacy impact are considered as well as the assessment of occurrence and the large-scale importance of the area for bird migration. For the protected asset bats, there are currently no reliable data sources for a criteria-based assessment. The protected asset biodiversity is assessed textually.

The following is a list of the criteria used for the status assessment of the respective protected asset. This overview addresses the protected assets that can be meaningfully delimited on the basis of criteria and are considered in the focus.

Area/seabed

Aspect: Rarity and threat
Criterion: Areal proportion of sediments on the seabed and distribution of the morphological form inventory.
Aspect: Diversity and uniqueness
Criterion: Heterogeneity of the sediments on the sea floor and development of the morphological inventory of forms.
Aspect: Legacy impacts
Criterion: Extent of anthropogenic legacy impact of seabed sediments and morphological form inventory*.

Benthos

Aspect: Rarity and threat
Criterion: Number of rare or endangered species based on the Red List species identified (Red List by RACHOR et al. 2013).
Aspect: Diversity and uniqueness
Criterion: Number of species and composition of the species communities. The extent to which species or communities characteristic of the habitat occur and how regularly they occur is assessed.
Aspect: Legacy impacts
For this criterion, the intensity of fishing use, which represents the most effective direct disturbance variable, is used as the assessment standard. Benthic communities can also be adversely affected through eutrophication. For other disturbance variables such as shipping traffic and pollutants, there is currently a lack of suitable measurement and detection methods to be able to include them in the assessment.

Biotopes

Aspect: Rarity and threat
Criterion: National protection status and threat of biotopes according to the Red List of Endangered Biotopes in Germany (FINCK et al., 2017).
Aspect: Legacy impacts
Criterion: Threat as a result of anthropogenic influences.

Fish

Aspect: Rarity and threat
Criterion: Proportion of species considered to be threatened according to the current Red List marine fish (THIEL et al. 2013) and for the diadromous species on the Red List freshwater fish (FREYHOF 2009) and assigned to Red List categories.
Aspect: Diversity and uniqueness
Criterion: The diversity of a fish community can be described by the number of species (α-Diversity, “species richness”). The species composition can be used to assess the specific nature of a fish community, i.e. how regularly habitat-typical species occur. Diversity and distinctiveness are compared and assessed between the North Sea as a whole and the German EEZ as well as between the EEZ and the individual areas.
Aspect: Legacy impacts
Criterion: Because of the removal of target species and by-catch as well as the adverse effect on the seabed in the case of bottom-disturbing fishing methods, fishing is considered to be the most effective disturbance to the fish community and therefore serves as a measure of the legacy impact on fish communities in the North Sea. There is no assessment of stocks on a smaller spatial scale such as the German Bight. The input of nutrients* into natural waters is another pathway through which human activities can influence fish communities. Eutrophication is therefore used for the assessment of the legacy impact.

Marine mammals

Aspect: Protection status
Criterion: Status under Annex II and Annex IV of the Habitats Directive and the following international protection agreements: Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention, CMS), ASCOBANS (Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas), Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention)
Aspect: Assessment of the occurrence
Criteria: Stock, 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 SDP for marine mammals as a migration area or feeding or breeding ground
Aspect: Legacy impacts
Criterion: Threats as a result of anthropogenic influences and climate change.

Seabirds and resting birds

Aspect: Protection status
Criterion: Status in accordance with Appendix I species of the Birds Directive*, European Red List of BirdLife International
Aspect: Assessment of the occurrence
Criteria: Population in the German North Sea and EEZ, large-scale distribution patterns, abundances, variability
Aspect: Assessment of spatial units
Criteria: Function of the areas identified in the SDP for relevant breeding birds and migratory birds as resting areas, location of protected areas
Aspect: Legacy impacts
Criterion: Threats as a result of anthropogenic influences and climate change.

Migratory birds

Aspect: The importance of bird migration over a large area
Criterion: Guidelines and areas of concentration
Aspect: Assessment of the occurrence
Criterion: Migration activity and its intensity
Aspect: Rarity and threat
Criterion: Number of species and endangered status of the species involved according to Annex I of the Birds Directive, Bern Convention of 1979 on the Conservation of European Wildlife and Natural Habitats, Bonn Convention of 1979 on the Conservation of Migratory Species of Wild Animals, African-Eurasian Waterbird Agreement (AEWA) and Species of European Conservation Concern (SPEC).
Aspect: Legacy impacts
Criterion: Legacy impact/threats as a result of anthropogenic influences and climate change.

1.5.4 Assumptions for description and assessment of likely significant impacts

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

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

Use	Effect	Potential impact	Protected assets																
			Benthos	Fish	Seabirds and rest-	Migratory birds	Marine Mammals	Bats	Plankton	Biotopes	Biological diversity	Seabed	Site	Water	Air	Climate	Human/ Health	Cultural and mate-	Landscape
Marine uses with spatial designations in the spatial plan																			
Areas for offshore wind energy	Placement of hard substrate (foundations)	Modification of habitats	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	Modification of habitats	x	x					x	x		x	x						
	Sediment turbulence and turbidity plumes (construction phase)	Impairment	x t	x t	x t				x t					x t					
		Physiological effects and deterrent 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/ scaring effect		x t			x												
		Potential disruption/damage		x t			x												
	Visual unrest due to construction activity	Local deterrent and barrier effects		x t	x t														

	Obstacle in airspace	Deterrent 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 (stone pile)	Modification of habitats	x	x					x	x		x						x	
		Habitat and land loss	x	x						x		x	x					x	
	Heat emissions (live cables)	Adverse effects on/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 deterrent effects		x t															
Shipping	Underwater Sound	Adverse effect/deterrent effect		x			x												
	Emissions and introduction of hazardous substances (accidents)	Impairment/ damage	x	x	x		x		x	x	x	x		x			x		
	Physical disturbance during anchoring	Adverse effect 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								
	Introduction of waste	Impairment/ damage	x	x	x		x		x					x			x		
	Risk of collision	Collision			x	x	x												
	Visual agitation	Impairment/ scaring effect		x	x														

Raw materials Sand and gravel mining/Seismic investigations	Removal of substrates	Modification of habitats	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 deterrent effects		x t															
	Physical disturbance	Adverse effect on the seabed	x							x		x	x					x	
	Underwater sound during seismic surveys	Adverse effect/deterrent effect		x t			x												
	Visual agitation	Adverse effect/deterrent effect			x														
Marine research	Removal of selected species	Reduction of stocks		x															
	Physical disturbance by trawls	Impairment/ damage to bycatch	x	x						x		x						x	
Fisheries	Removal of selected species	Reduction of stocks	x	x							x								
		Deterioration 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	
National defence	Underwater Sound	Impairment/ chickening out effect		x t			x												
	Introduction of dangerous* substances	Impairment	x	x	x		x		x	x	x	x		x			x		
	Risk of collision	Collision					x												
	Surge noise*	Impairment/ scaring effect			x	x		x									x		
	Introduction of waste	Impairment	x	x					x					x			x		
Marine uses without spatial designations in the spatial plan																			
Leisure (-traffic)	Removal of species (fishing)	Reduction of stocks		x															
	Underwater Sound	Adverse effect/deterrent effect		x			x												
	Emission of air pollutants	Impairment of air quality			x	x		x							x	x	x		
	Introduction of waste	Impairment	x	x	x		x		x					x			x		
	Visual agitation	Impairment/ scaring effect			x														
Aquaculture	Introduction of nutrients	Impairment	x	x					x					x					
	Introduction of fixed installations	Modification of habitats	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								
	Introduction of medi-cations	Impairment	x	x										x			x		
	Removal from wild stocks	Impairment	x	x															
	Attraction/scaring ef-fects	Attrac-tion/deter-rent effect		x	x		x												

x potential impact on the factor

x t potential temporary impact on the factor

Cumulative effects on and interrelationships between protected assets are also assessed in addition to the impacts on the protected assets.

1.5.4.1 Cumulative view

According to Article 5, paragraph 1 SEA Directive, the environmental report also includes an assessment of cumulative impacts. Cumulative impacts arise from the interaction of various independent individual effects, which either add up as a result of their interaction (cumulative effects) or reinforce each other and thus generate more than the sum of their individual effects (synergetic effects) (e.g. SCHOMERUS et al., 2006). Both cumulative and synergetic impacts can be caused by both temporal and spatial coincidence of effects. In this context, the effect can be intensified by similar uses or different uses with the same effect, thus increasing the impact on one or more protected assets.

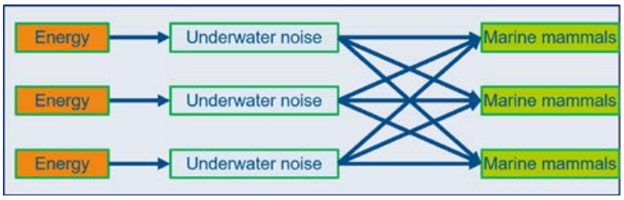


Figure 8: Exemplary cumulative effect of similar uses.

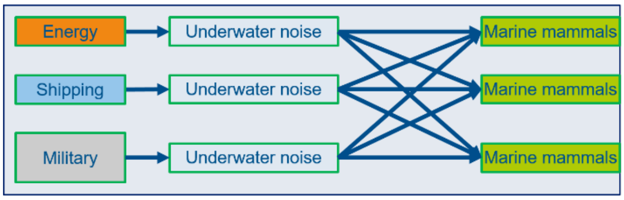


Figure 9: Exemplary cumulative effect of different uses.

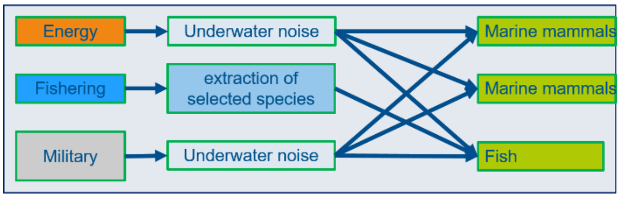


Figure 10: Exemplary cumulative effect of different uses with different impacts.

In order to examine the cumulative impacts, it is necessary to assess the extent to which the designations of the plan can be attributed a significant negative impact when taken together. An assessment of the designations is carried out on the basis of the current state of knowledge within the meaning of Article 5, paragraph 2 SEA Directive. An important basis for assessing the impacts of habitat loss and underwater noise is provided by the position paper on the cumulative assessment of the loss of diver (bird) habitat in the German North Sea (BMU, 2009) and the noise abatement concept of the BMUB (2013).

1.5.4.2 Interrelationships

In general, impacts on a protected asset lead to various consequences and interrelationships between the protected assets. The essential interconnection of the biotic protected assets exists via the food chains. Because of the variability of the habitat, interrelationships can only be described in a very imprecise manner overall.

1.5.4.3 Specific assumptions for the assessment of likely significant environmental impacts

In detail, the analysis and assessment of the respective designations is carried out as follows:

Offshore wind energy

With regard to the priority and reservation areas for offshore wind energy, a worst-case scenario is generally assumed. In this SEA, certain parameters in the form of bandwidths spatially separated into Zones 1 and 2 and Zones 3 to 5 are assumed for a consideration related to protected assets. In detail, these are, for example, the power output per installation [MW], hub height [m], rotor diameter [m] and total height [m] of the installations.

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

- Installations already in operation or in the approval procedure (as reference and legacy impact)

- Transfer of the average parameters of the installations commissioned in the last 5 years on the sites defined in SDP 2019
- Forecast of certain technical developments for the additionally defined priority and reservation areas for offshore wind energy in the ROP based on the parameters presented. It should be noted here that these are only partly estimation-based assumptions because project-specific parameters are not or cannot be checked at SEA level.

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

Wind Turbine Generator (WTG) Parameters	**Range** *Zones 1 and 2*		**Range** *Zones 3–5:*	
	from	to	from	to
Power per installation [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 connecting cables of the priority areas for offshore wind energy, the route length (EEZ) varies between about 10 km and 160 km. For the priority areas in Zones 4 and 5, an average route length of about 250 km is assumed. For the assessment of the construction and operational environmental effects, certain widths of the cable trench [m] and a certain site of the intersection structures [^{m2}] are assumed for submarine cable system rout corridors. In particular, the environmental impacts of construction, operation, and repair are considered.

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

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 designations in the ROP.

The designated priority areas for shipping are to be kept free of building use. This control in the ROP is intended to prevent or at least reduce collisions and accidents. Because of the designations 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 considerably, with the most heavily used route SN1 sometimes carrying more than 15 vessels per km² per day, while on the other, narrower routes there are usually about 1-2 vessels per km² per day (BfN, 2017).

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

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

The presentation of general impacts from shipping is presented in Chapter 2 as a legacy impact, particularly on birds and marine mammals. The impacts of service transport to the wind farms are discussed 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 by means of floating suction dredgers. The extraction field is driven over in strips of approximately 2 m width and the subsoil is extracted to a depth of approximately 2 m. The seabed remains unstressed between the excavation strips. During mining, a sediment-water mixture is pumped on board the suction dredger. The sediment in the desired grain size is screened out and the unused portion is returned to the sea on site. Turbidity plumes result from the mining and discharge. Potential temporary impacts result from the turbidity plumes, which may lead to adverse effects and deterrent effects on marine fauna. Potential permanent impacts arise from substrate removal and physical disturbance causing habitat and area loss, habitat modification, and adverse effects on the seabed.

Sand and gravel extraction is carried out on the basis of operational plans on sub-sites of the approved permit fields.

Gas production:

Exploratory or production wells are drilled to explore and develop gas deposits. Drilling through the rock lying above the deposit results in drilling abrasion. 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; these lead to deterrent effects on marine mammals.

Operational discharges into the sea are caused by the discharge of production water and spray water, waste water from the sewage treatment plant, and the shipping traffic generated. Production water is essentially reservoir water, which may contain components from underground (e.g. salts, hydrocarbons, and metals). As the reservoir ages, the amount of gas in the production water increases. Production water can also contain chemicals that are used in mining to improve extraction or to prevent corrosion of production equipment. The production water is discharged into the sea after treatment in accordance with the state of the art and compliance with national and international standards.

Fisheries and marine aquaculture

In the area of the southern silt floor, the sediment provides a particularly suitable habitat for this species, which can be quite clearly defined spatially. The demarcation of the reservation area for Norway lobster fishery was based on an evaluation by the Thünen Institute for Sea Fisheries* for the BSH, created by an intersection of VMS data and logbook data (2012 to 2018) (Letschert & Stelzenmüller, 2020). The stock of Norway lobster in the North Sea is considered stable and is classified as not threatened (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. Adverse effects of fishing in this area mainly affect the seabed, sediment and the habitats affected by it, which can be affected by the trawls used.

Table 3: Parameters for the consideration of fisheries.

Fishing effort (German fleet)	Approximately 8,000 hrs/year (2013) to 14,000 hrs/year (2018) 12 (2014) - 18 (2015) vehicles
Fishing gear used	Bottom trawls
Catches	200 - 350 t / year (plus non-German fisheries)

Marine research

The designated areas for scientific marine research (3 in the North Sea, 4 in the Baltic Sea) correspond to standard investigation areas ("boxes") of the Thuenen Institute in the North Sea and the Baltic Sea. In the North Sea, the German Small-Scale Bottom Trawl Survey (GSBTS), which has been carried out since 1987, has been collecting data on the development of fish populations over many years. 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. fisheries).

The GSBTS uses a standardised bottom trawl net or a high-density GOV otter trawl to sample small-scale bottom fish communities to determine abundances and distribution patterns. In parallel, epibenthos (using a 2 m beam trawl), infauna (using a Van Veen grab) and sediments will be studied, and hydrographic and marine chemical parameters in habitats typical of the region will be recorded.

Effects are to be expected from the equipment used, in particular on the soil/sediment and the habitats affected by it. To this end, fish of various ages and sizes 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 beam trawl (epibenthos) Van Veen gripper (Infauna)
Catches	Total quantities for all (sampled) boxes (partly with other research activities) in double-digit tonnes

Nature conservation/seascape/open space

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

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 scope of the rules is of particular importance in this context, with the EEZ accounting for 37.92% of the area of the North Sea. The priority areas for nature conservation contribute to safeguarding open space because uses incompatible with nature conservation are excluded in them. contributes to preventing any disturbances caused by the implementation of wind energy and to ensuring the protection of the marine environment. Keeping protected areas free of structural installations also contributes to the protection of open space and the seascape on a large scale.

The designation of the main distribution area of harbour porpoises and the main concentration area of loons as reserved areas is of outstanding conservation importance for the protection of the disturbance-sensitive group of loons and harbour porpoise species.

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 prevent or mitigate adverse effects on the natural balance.

The 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 allied defence

The ROP contains textual designations on national and allied defence.

1.6 Data bases

The basis for the SEA is a description and assessment of the state of the environment in the area of investigation. All protected assets must be included in this process. The data availability forms the basis for the assessment of the likely significant environmental impacts, assessment of natural habitat and wildlife conservation regulations and the examination of reasonable alternatives.

According to Section 8, paragraph 1, sentence 3 ROG, the environmental assessment refers to what can reasonably be required according to the current state of knowledge and generally accepted testing methods as well as the content and level of detail of the spatial plan.

On the one hand, the environmental report will describe and assess the current state of the environment, and describe the likely development if the plan is not implemented. Second, the likely significant environmental impacts resulting from the implementation of the plan are predicted and assessed.

The basis for the assessment of potential impacts is a detailed description and assessment of the state of the environment. The description and assessment of the current state of the environment and the likely development in the event of non-implementation of the plan will be carried out with regard to the following protected assets:

- Area/seabed
- Water
- Plankton
- Biotopes
- Benthos
- Fish
- Marine mammals
- Avifauna
- Bats
- Biological diversity
- Air
- Climate
- Landscape
- Cultural assets and other material assets
- People, especially human health
- Interrelationships between protected assets

1.6.1 Overview of data sources

The data and knowledge situation has improved considerably in recent years, particularly as a result of the extensive data collection within the framework of environmental compatibility studies and the construction and operational monitoring for the offshore wind farm projects and the accompanying ecological research.

This information also forms an essential basis for the monitoring of the 2009 spatial plans in accordance with Section 45, paragraph 4 UVPG. Thereafter, the results of the monitoring shall be made available to the public and taken into consideration when the plan is drawn up again. The results of the 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 (Chapter 2.5), which was published in parallel.
In general, the following data sources are used as a basis 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 site investigation
- Results from the monitoring of Natura 2000 areas
- Mapping instructions for Section 30 biotopes
- MSFD initial and progress evaluation
- Findings and results from R&D projects commissioned by BfN and/or 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 sources is included in the annex to the framework of the study.

1.6.2 Indications of difficulties in compiling the documents

According to No. 3a Annex 1 to Section 8, paragraph 1 ROG, indications of difficulties encountered in compiling the information (e.g. technical gaps or lack of knowledge) shall be presented. There are still gaps in knowledge in places, especially with regard to the following points:

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

In principle, forecasts on the development of the living marine environment after the ROP has been carried out 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 caused by 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.

Furthermore, there are no scientific assessment criteria for some protected assets, 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, to allow cumulative effects to be considered in both temporal and spatial terms.

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

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

1.7 Application of the ecosystem approach

The application of the ecosystem approach can contribute to achieving the guiding principle of sustainable spatial development in accordance with Section 1, paragraph 2 ROG, which reconciles the social and economic demands on space with its ecological functions and leads to a sustainable, large-scale balanced order. The application is a requirement according to Section 2, paragraph 3, No. 6, sentence 9 ROG with the objective of guiding human activity, sustainable development, and supporting sustainable growth (cf Art. 5, paragraph 1 MSP Directive* in conjunction with Art. 1, paragraph 3 Marine Strategy Framework Directive).

Recital 14 of the MSPD 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.

In accordance with Article 5, paragraph 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”.

Article 1, paragraph 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 adversely affected, while allowing for the sustainable use of marine goods and services now and by future generations”.

The ecosystem approach allows 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 interrelationships of their uses. The approach is to manage ecosystems within the "limits of their functional capacity" in order to safeguard them for use by future generations. In addition, 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 status of the marine environment.

Based on the so-called twelve Malawi principles of the Biodiversity Convention, the ecosystem approach has also been concretised by the HELCOM-VASAB working group on maritime spatial planning and specified for marine 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 is intended to promote an overall picture that is as comprehensive as possible:

- Best available knowledge and practice;
- Precautions;
- Alternative development;
- Identification of ecosystem services;
- Prevention and mitigation;
- Relational understanding;
- 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 greatest challenges is dealing with gaps in knowledge. 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 use the broadest possible knowledge base of all stakeholders and to achieve the greatest possible acceptance of the plan.

The Figure 11 shows 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 is proving to be the central instrument for applying the ecosystem approach (Altvater, 2019) and offers versatile points of connection to the substantive and process-oriented key elements.

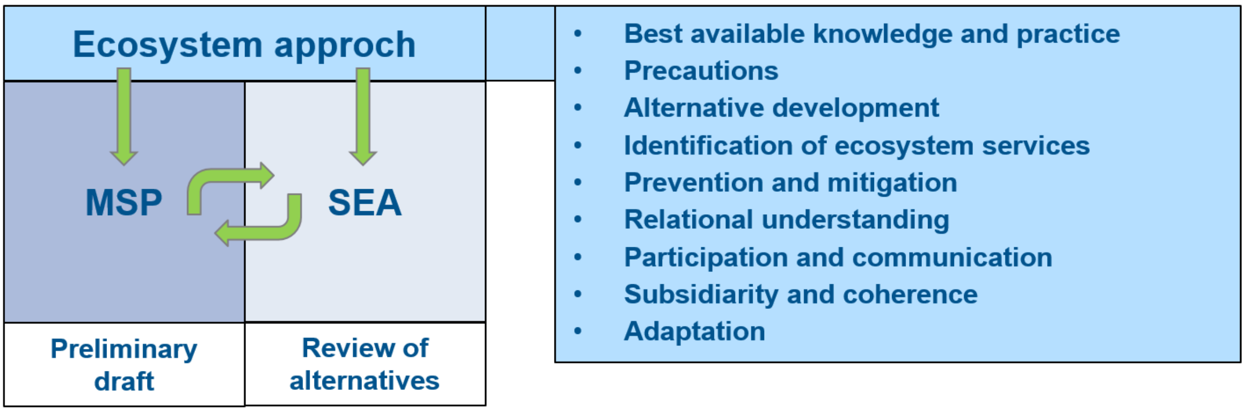


Figure 11: The ecosystem approach as a structuring concept in the planning process, in the ROP, and in the Strategic Environmental Assessments

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

- Principles on general requirements for economic uses: Prevention of threat 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);
- Principles on nature conservation: Bird migration (6) and conservation of the EEZ as a natural area (7)

The spatial and textual designations for marine nature conservation fundamentally contribute to the protection and improvement of the status of the marine environment (see mission statement of the ROP). In addition, the designations of the ROP promote the resilience of the marine environment – against impacts from economic uses as well as against changes resulting from climate change.

A quantification of the carrying capacity* of the ecosystem cannot be considered conclusively because of a lack of data and knowledge. This represents 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 designations on economic uses, does not exceed the limits of ecosystem functioning.

The assessment of the likely significant environmental impacts of the implementation of the spatial plan are methodologically described in Chapter 1.5.2 . The ecosystem approach is not itself an assessment; however, it encompasses a variety 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 diversity and the comprehensive view of the relationship between the marine environment and economic uses. The key elements also interact with each other, underlining the interconnectedness and holistic perspective. Figure 12 abstractly shows the relationships between the key elements. This approach becomes tangible and applicable by looking at the level of the individual key elements – here in particular those of the HELCOM/VASAB Directive (2016).

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

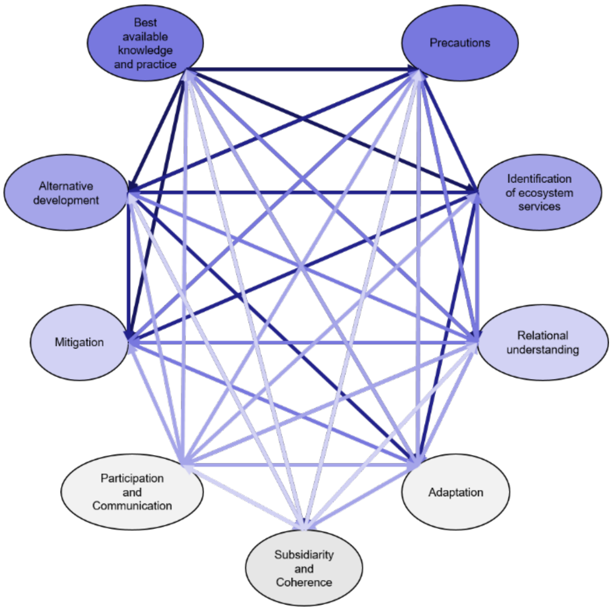


Figure 12: Networking between the key elements

Best available knowledge and practice

"The allocation and development of human uses will be based on the most recent knowledge of ecosystems as such and the practice of the best possible 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 is the basis of the planning understanding for the update of the spatial plans. This key element thus also affects the other elements mentioned, such as the precautionary principle, the avoidance and reduction of impacts and the understanding of interrelationships.

As part of the update process, the knowledge base is supplemented with the sector-specific expertise of stakeholders through an early and comprehensive participation process. Thematic workshops and technical discussions with various stakeholders were held even before the concept for the update was developed.

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 consideration for the plan preparation process. In addition to improving the level of knowledge, this contributes to the key element of "subsidiarity and coherence".

At the BSH, in-house research and developments such as databases and other analysis tools are developed, validated, and used 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 designations of the 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 highly 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 in accordance with StUK, from scientific research activities, and from national and international monitoring programmes.

Precautions

“Far-sighted, anticipatory, and preventive planning should promote sustainable use in marine areas and eliminate risks and threaten of human activities to the marine ecosystem. Those activities that, 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 examination and weighting of the risks” (HELCOM/VASAB, 2016).

The precautionary principle has a high priority in spatial planning, particularly because of 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 designations of the spatial plan clarify the consideration of the precautionary principle in economic uses as a fundamental requirement (Principle 7 Nature Conservation/Marine Landscape/Open Space) as well as in the following uses:

- Objective for shipping: Priority areas for shipping (1);
- Objective on general requirements for economic uses: Deconstruction (2);
- Principles on general requirements for economic uses: Sustainability, land conservation (1), and prevention of threat to the marine environment and best environmental practice (4.1);
- Principle on offshore wind energy: Protection of the marine environment (6);
- Principles on lines: Minimising adverse effects (5) and marine environment (6);
- Principle on nature conservation: Conservation of the EEZ as a natural area (7).

The SEA examines the significance of the impacts of the designations of the ROP on uses on the protected assets (Chapter 4).

Alternative development

"Reasonable alternatives should be developed to find solutions to avoid or reduce negative impacts on the environment and other areas, as well as on ecosystem goods and services".

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

- Planning option A: Perspective on traditional uses
- Planning option B: Climate protection perspective
- Planning option C: Marine nature conservation perspective

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

A preliminary assessment of selected environmental aspects was carried out before this environmental report was prepared. This preliminary assessment allowed a comparison of the three planning options from an environmental point of view in the sense of an early examination of reasonable alternatives and variants.

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 were incorporated into the planning process at an early stage.

An examination of reasonable alternatives to the ROP is carried out 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 must be identified".

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 because they can clarify the multiple functions of ecosystems. In the case of marine ecosystems, particular emphasis should be placed on their function as natural carbon sinks and other contributions to climate protection and adaptation. This consideration should be taken into account in future updates of the 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, high-resolution information network on marine ecology data from environmental investigations in the context of environmental impact studies, 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 tasks of the BSH as required. MARLIN also combines the integrated marine ecological data with various environmental data to support the understanding of impacts and interconnections 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 to look at all offshore wind farm procedures and create large-scale studies. Based on this, an identification of ecosystem services can begin. The holistic approach of MARLIN 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.

Prevention and mitigation

"The measures are intended to prevent, reduce and as fully as possible offset any significant negative environmental impact [of the implementation of the plan].

The mission statement of the ROP defines the contribution to the protection and improvement of the status of the marine environment also by designating the prevention or mitigation of disturbance and pollution.

The designations of the spatial plan clarify this consideration with measures for the prevention 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 lines: Minimising adverse effects (5) and marine environment (6);
- Principle on marine research: Sustainability, protection of the marine environment (3);
- Objective for nature conservation: Priority areas for nature conservation and priority area for divers (1);
- Principles on nature conservation: Multiple use priority area for divers (3), seasonally limited reservation area for the harbour porpoise (4), bird migration corridors (6), and safeguarding and conservation of the seascape (9).

In the SEA, measures for the prevention, mitigation, and compensation of significant negative impacts of the implementation of the spatial plan are comprehensively presented in Chapter 8.

Relational understanding

“It is necessary to take into consideration various impacts on the ecosystem caused by human activities and interrelationships between human activities and the ecosystem as well as between different human activities. These include direct/indirect, cumulative, short-/long-term, permanent/ temporary and positive/negative effects and interrelationships, including sea/land interrelationships".

The understanding of interconnections and interrelationships is of high importance for the planning process and the tasks of spatial planning. In this sense, the mission statement of the ROP emphasises the holistic approach and includes the consideration of land-sea relations.

The Strategic Environmental Assessment addresses and examines this in the Chapters 4.10 Interrelationships and 4.11 Cumulative consideration.

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

Further experience, e.g. on cumulative consideration, has been gained in European cooperation projects (Pan Baltic Scope, SEANSE) and will be incorporated into the further conceptual development, as will 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 broader public should be involved in the planning process at an early stage. The results are to be communicated." (HELCOM/VASAB, 2016).

This key element is an example of the networking and relationships between 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 scope of investigation 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 Wissenschaftlicher Begleitkreis* (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 questions of content as well as the course of the procedure and the participation process.

Subsidiarity and coherence

"Maritime spatial planning, with an ecosystem approach as the overarching principle, will be carried out at the most appropriate level and will seek coherence between the different levels (HELCOM/VASAB, 2016).

The objective of spatial planning is to create coherent plans in the North Sea and the Baltic Sea by coordinating with the coastal states and neighbouring countries. 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 procedures for plan preparation in neighbouring countries within the framework of international cooperation are taken into account for the process of plan preparation. The international consultation procedures represent a further contribution.

The ROP's mission statement sets forth this cooperation as a contribution to coherent international marine spatial planning and coordinated planning with coastal countries.

At the level of the designations, the following objectives and principles highlight the need for coordination in planning cross-border structures:

- Destinations for shipping: Priority areas for shipping (1) and temporary priority area for shipping (2);
- Objective for lines: Territorial waters gate (3);
- Principle on lines: Suitable transition points at the territorial waters and gates to neighbouring states (4);
- Principle on nature conservation: Bird migration corridors (6).

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

Adaptation

"Sustainable use of the ecosystem should be an iterative process involving monitoring, review and evaluation of both the process and the outcome".

Monitoring and evaluation within the framework of spatial planning for the German EEZ take place at various levels.

The first step will be to evaluate the plan and its implementation. A monitoring and evaluation concept will be developed for this purpose.

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

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

The impacts of economic uses on the marine environment are to be investigated and evaluated at project level by means of effect monitoring. This is laid down 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, and 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 status of the marine environment.

1.8 Taking climate change into account

Anthropogenic climate change as one of the greatest societal challenges is of particular importance for changes in the oceans as well as their use. The Figure 13 presents the interconnections between climate change, the marine ecosystem, uses, and maritime spatial planning – also as an instrument for achieving the objectives for sustainable development.

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

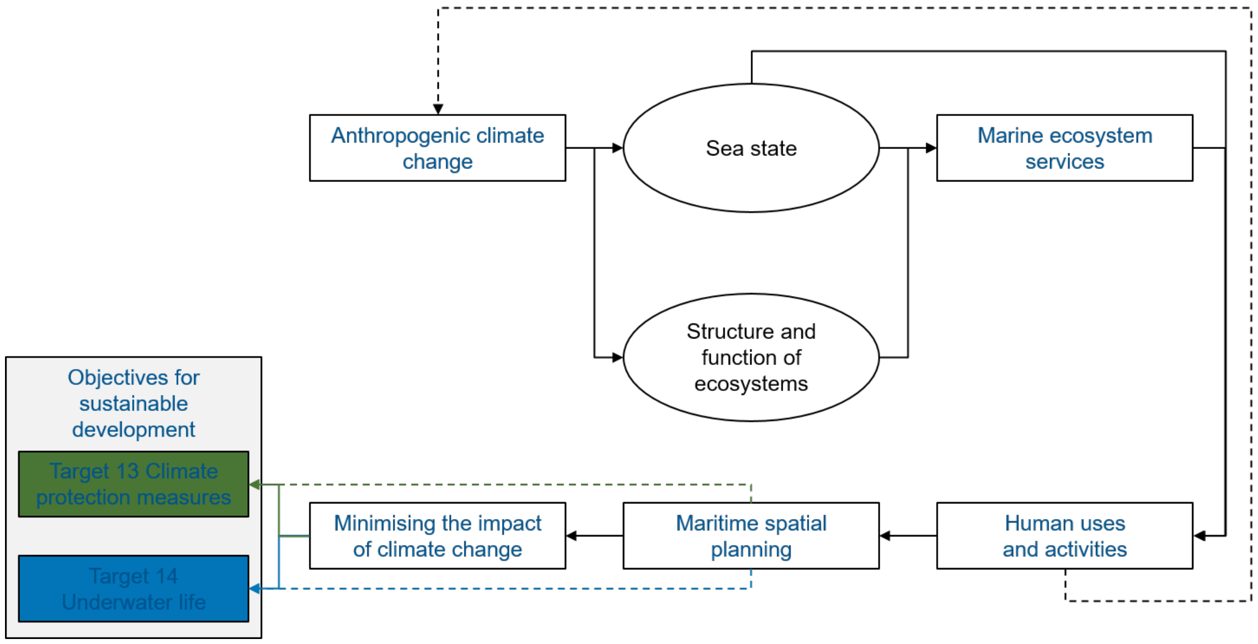


Figure 13: Representation of the interrelationships between climate change, marine ecosystems and maritime spatial planning, according to (Frazão Santos, 2020)

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 the uses to which they are put, e.g. shipping, renewable energy or extraction of raw materials (Frazão Santos, 2020).

The following table shows projections for 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). Percentile of the RCP8.5 scenario compared with 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 with 1971–2000)[1]	2.5 – 3 °C	2.5 – 3.5 °C
Global sea level rise 2100 (RCP8.5 scenario vs. 1986-2005)[2]	61–110 cm	61–110 cm
Increase in extreme wind speeds (RCP8.5 scenario compared with 1971–2000)[3]	0 – 0.5m/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 designations on offshore wind energy should be mentioned first and foremost. Assuming that the update of the current CO_2 avoidance factor of electricity from offshore wind energy (UBA, 2019) is extrapolated to the year 2040 to the year 2040, this results in a CO_2 avoidance potential of 62.9 Mt CO_2 equivalents per year on average for the period between 2020 and 2040. For comparison: Annual emissions from power plants in the energy industry were 294.5 Mt CO_2 equivalents per year in 2016 (BMU, 2019).

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

Table 6: Calculation of the CO_2 avoidance potential of the offshore wind energy provisions

	Installed capacity	Full load hours	Annual electricity production	CO_2 avoidance factor	CO_2 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 CO_2 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 reservation areas of nature conservation can also serve to strengthen 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 targets.

The development of risk and vulnerability analyses to 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. To promote this, a dialogue could be initiated to ensure that a joint discussion takes place in a spatial planning forum with stakeholders from the sectors.

For the comprehensive inclusion of climate change in the MRO, a strengthening of institutional cooperation, including international cooperation in the North Sea and Baltic Sea, is necessary. 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 on the conceptual development of marine ecosystem services and, above all, the potential of natural carbon sinks.

2 Description and assessment of the environmental status

According to Section 8 ROG in conjunction with Annex 1 and 2 to Section 8 ROG, the environmental report contains a presentation of the characteristics of the environment and the current state of the environment in the area of investigation of the SEA. The description of the current state of the environment is required in order to be able to forecast its change upon implementation of the plan. The subject of the inventory are the protected assets listed in Section 8, paragraph 1 ROG as well as interrelationships between them. The information is presented in a problem-oriented fashion. Emphasis is therefore placed on possible legacy impacts, 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 oriented towards the respective environmental impacts of the plan. These vary in extent depending on the type of impact and the protected asset affected and can extend beyond the boundaries of the plan.

2.1 Site

The German EEZ in the North Sea and Baltic Sea is of high importance for many uses and for the marine environment. At the same time, their area is limited; land-saving use is thus imperative. Land economy is therefore also reflected in the guidelines and principles of the spatial plan; as a result of this, the protected asset land has a special significance in the ROP in principle and across all uses.

One guiding principle of spatial planning is the sustainable development of space (cf Section 1, paragraph 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 result in the ROP for uses not always specifying the desirable area 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 a protected asset.

When all the designations of the plan are considered together, the impression may arise that hardly any (if any at all) land in the German EEZ remains unused. On one hand, the designation of a site for a certain use does not necessarily mean that this site is also 100 % taken up by this use. Second, not all uses take place at the same time or over the entire period. Spatial planning in the sea can take advantage of a three-dimensional space; this can lead to an overlapping of uses on one site as in the case of the uses of lines and shipping, for example. Even uses that actually take up land in the sense of seabed do not necessarily take up 100% of it. One example is the use of offshore wind energy. The actual land consumption by wind turbines and platforms (including scour protection) as well as in-park cabling amounts to less than 0.5% of the areas designated for offshore wind energy.

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

2.2 Seabed

2.2.1 Data situation

An important basis for the description of the surface sediments of the EEZ of the North Sea 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 14). This map was initially only available for the German Bight and was updated and extended to the entire German EEZ of the North Sea with the GPDN project and the map by Laurer et al. 2014. Like the previous version, the mapping is based on point distributed grain size distributions from surface bottom samples, which were classified according to the sediment classification system of Figge (1981) and interpolated into the area. Within the framework of the sediment mapping EEZ project, area-wide sediment mapping using hydroacoustic methods has been carried out for several years now (BSH, 2016). In addition to the larger scale of 1:10,000, the applied methodology offers the advantage that spatial interpolation of point samples is no longer necessary. The resulting detailed maps improve the state of knowledge of small-scale structural and sediment changes on the seabed surface enormously (Figure 15 a/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 blocks (Figure 15 c) can thus be filled. Therefore they are a valuable data source for detailed biotope mapping. The maps are not yet available for the entire EEZ of the North Sea; however, the protected areas are largely surveyed (see Figure 14 and www.geoseaportal.de).

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

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

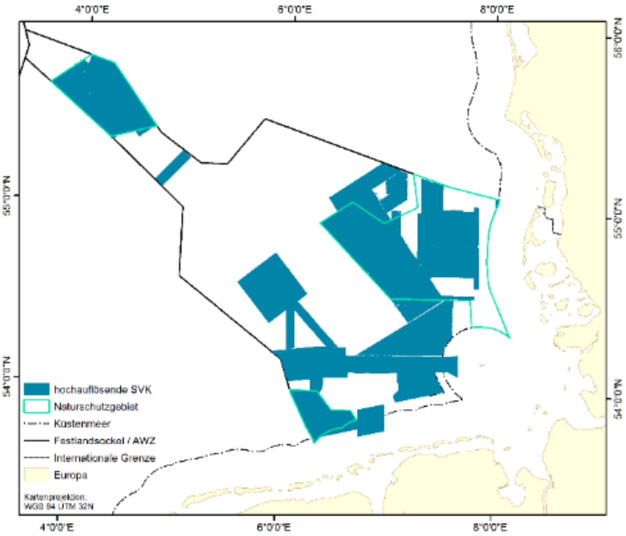


Figure 14: Detailed sediment distribution maps scale 1 : 10,000 (current data availability)

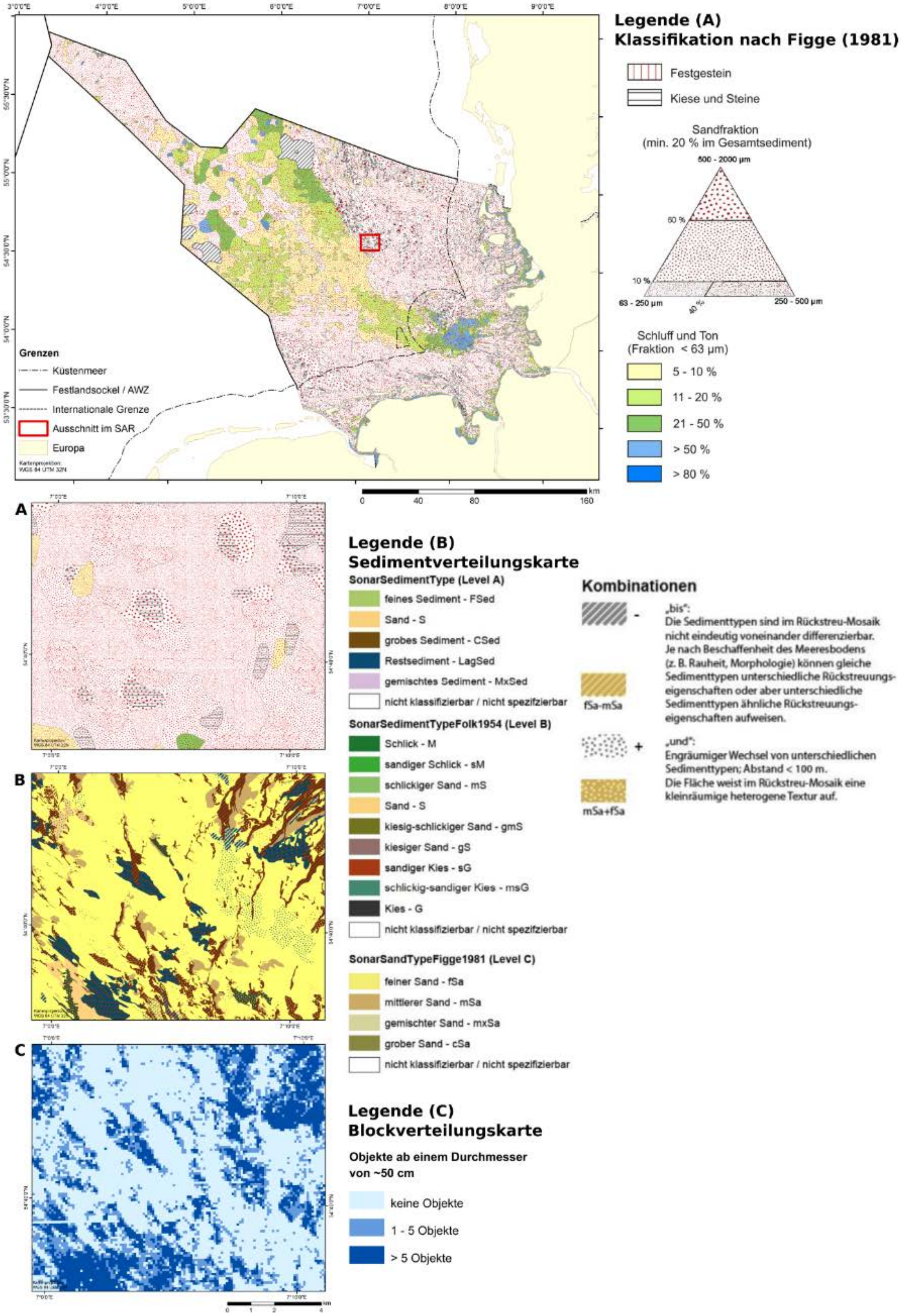


Figure 15: a/b) Comparison of interpolated and areal sediment distribution maps. c) Block distribution map

2.2.2 Geomorphology and sedimentology

The area under review - the German EEZ of the North Sea - extends from the seaward boundary of the coastal waters of Lower Saxony and Schleswig-Holstein to the so-called "Duck's Bill", the elongated extension in the extreme north-west of the German EEZ, which reaches into the central North Sea. The bathymetry of this area can be found at Figure 16 .

The former Elbe-Urstromtal valley divides the EEZ of the North Sea into a western and an eastern sub-area, thereby resulting in a regional geological division into four regions (Figure 16):

- Borkum and Norderney Reef Grounds (1),
- North of Helgoland (2),
- Elbe Glacial Valley and western plains (3),
- Dogger and Northern Shell Bank (4).

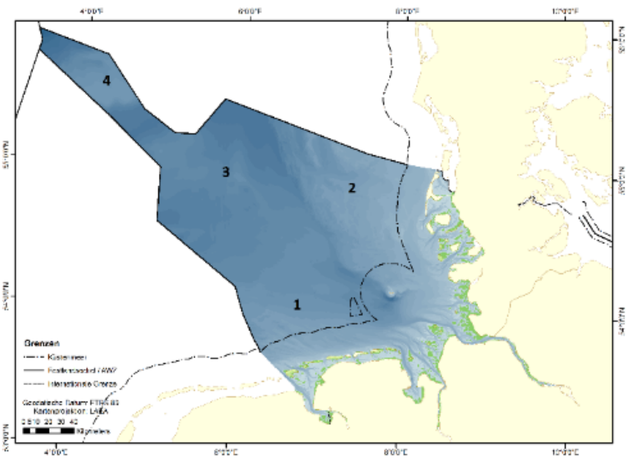


Figure 16: Bathymetry in the EEZ and regional geological classification

Borkum und Norderneyer Riffgrund

This sub-area covers the area of the Borkum and Norderney Reef Grounds between the two traffic separation areas "German Bight Western Approach" and "Terschelling German Bight" and borders in the east on the 12-nautical mile limit off Helgoland.

The seabed drops evenly from 18 m in the south-west to 42 m in the north and 36 m in the east. Along the 12nautical mile limit with the coastal waters of Lower Saxony, the extensions of the tongue reefs (shoreface connected sand ridges) as defined by REINECK (1984) extend into the EEZ. They run in a northwest-southeast direction and are subject to pronounced sediment dynamics. Their core remains largely stable, while their surface layer is subject to horizontal changes of between 100 and 200 m per year (ANTIA, 1996). On a small scale, ripple fields of varying intensity are observed on the sandy areas, which indicate recent sediment transport or sand relocation.

The sediment distribution on the seabed in the area of the Borkum and Norderney Reef Grounds is predominantly heterogeneous. Mainly medium to coarse sandy sediments are found here, with gravel as a secondary source. Stones can occur in the entire area of the reef grounds. New findings from the comprehensive sediment mapping show a wide range of stones, blocks and boulders in the Borkum Reef Ground. Towards the northeast and east, and with increasing water depth, the sediments turn into medium to fine sands, whose share of silt and clay reaches up to 10% in places, and can rise to 20% in the area of the formerElbe Glacial ValleyElbe Glacial Valley (Laurer et al, 2014).

Holocene and Pleistocene sediment layers can be identified in the shallow subsurface. Under a 0.5 to 2.5 m thick cover of North Sea sands (Nieuw Zeelandgronden Formation), periglacial fine sands of the late Weichselian period are found, which contain clay layers and stones in places (Twente Formation) and can reach thicknesses of up to 16 m. In the area of the reef grounds, both formations wedge out; there, worked up ground moraine deposits from the Saale Cold Period are located under a coarse sandy to gravelly residual sediment cover on the seabed. The sandy-clayey boulder clay, which can locally carry boulders or stones, is deposited on Eemian sea sands, which consist of a sandy sedimentary sequence from the late Elster and early Holstein periods and 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. Peat can also be expected in layers. The channels meander in the subsoil, but according to previous findings they are spatially limited.

North of Heligoland

This sub-area extends from the 12-nautical mile limit off North Frisia seawards to the eastern bank of the formerElbe Glacial ValleyElbe Glacial Valley and ends in the north at the EEZ border with Denmark.

Water depths range from 9 m on the western edge of the Amrumbank to 50 m in the northwest of the sub-area. Morphologically, the western part in particular is characterised by a relief that is very unsettled for conditions in the German Bight. Particularly noteworthy are the prominent submarine Geestkante along theElbe Glacial Valley, the western edge of the Amrumbank and the ridges in the northern area extending from the Danish base into the German EEZ. Characteristic inventory of forms are large or megaripple fields, coarse sand strips and erosion furrows, the formation of which is closely related to sediment availability, 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-area is characterised by a pronounced heterogeneous sediment distribution on the seabed. In addition to fine and middle sands, coarse sands and gravel are also common. The proportion of fine grains rarely exceeds 5% (Laurer et al, 2014). Pleistocene altitudes were worked up and partially levelled during sea-level rise. They show the characteristic covering with residual or relic sediments (coarse sand, gravel, boulders and erratic blocks). Between these residual sediment deposits, fine to middle sand areas 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 located directly on the seabed. In contrast to the Borkum and Norderney Reef Grounds, a higher density of rocks on the seabed can be observed in this sea area, which are concentrated in northwest-southeast facing 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 to the east of the former Elbe-Urstromtal (cf Figure 15 a-c).

The structure of the upper seabed is largely determined by the Saalian glacier advance (Warthe stage). The subsoil is traversed to varying degrees by filled meltwater channels and depressions. According to the data available to date, it can be assumed that the main drainage of this glacial channel system is directed NW to W. These structures contain clastic sediments such as sands, clays, silt and gravels as well as organogenic sediments such as peat.

Elbe glacial valley and western plains

This sub-area extends northwest of Helgoland to the German-Danish or German-Dutch EEZ border, but excludes the area of the so-called Duck's Bill. To the east is the eastern bank of the formerElbe Glacial Valley, which is a striking

Geestkante on the seabed, the border to the sub-area "North of Helgoland". This area north of the traffic separation areas has water depths between about 30 m and 50 m and slopes slightly from southeast to 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 balanced relief and is largely flat. Occasionally, side-scan sonar images reveal depression-like formations, in which the content of finer-grained material usually increases. Occasionally ripple fields occur, probably caused by ground currents. The sea bed surface consists of fine sands with significant contents of silt and clay. In the area of theElbe Glacial Valley, the recent surface sediments show an increase in clay and silt contents of up to 50%, which correlates with the water depth. The fine sands show a good to very good grading. Occasionally, small-scale gravel deposits can occur locally. In the plains to the west of the formerElbe Glacial Valley, stone deposits are also to be expected to a small extent.

The defining element in the subsoil is theElbe Glacial Valley located in the eastern part of the area, which runs along the submarine edge of the Geestkante to the northwest and north. This formerly approx. 30 km wide valley has been filled up in the course of the Holocene sea transgression, first with an alternating layer of fine sandy and silty-clayey sediments, later mainly with sandy sediments. The thickness of the sediment fill reaches approx. 20 m. However, in the area of the adjacent plains to the west, thicknesses of 1 m are exceeded only in exceptional cases. Below this, mostly dense fine to middle sands with coarse sand intercalations follow. They can contain gravel and shell layers , occasionally also clays, silt or peat.

Doggerbank and Northern Shillbank

This area includes the area known as the "Duck's Bill", the elongated extension in the extreme northwest of the EEZ, which lies in 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 northeastern foothills, the Tail's End, crosses the area as a submarine ridge. The shallowest water depths of 29 m are found on Dogger Bank, while the deepest depths of 69 m are measured on its northwestern flank. Pronounced bottom shapes such as sand waves or large or megaripple fields, as found on the British side, have not been observed in this sub-area. The seabed is generally relatively poor in structure.

Sedimentologically, the seabed surface mainly consists of a very well sorted fine sand cover, occasionally interrupted by patchy deposits of silt and clay or coarse sand sediments.

The Dogger Bank contains a Pleistocene core of Weichselian sediments (Dogger Bank Formation), which is located under Holocene North Sea sands up to 15 m thick. The Dogger Bank Formation consists of stiff to very stiff, silty clay, which locally carries gravel and stones and can reach a thickness of several tens of metres. The sediments of the Dogger Bank Formation probably extend to the southeastern border of the Duck's Bill. Late Weichselian gullies occur in its area, which are filled with soft, silty clays. In the northwestern slope area of Dogger Bank the Holocene sand cover thins out or is completely missing in places. Between the Dogger Bank and the northern Shell Bank, the 2 to 16 m thick periglacial fine sands occur, which may locally contain clay layers and stones. These are deposited on the marine fine sands from the Eemian warm period, which can be traced through the entire sub-area with thicknesses between 2 and 16 m.

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 by resuspension of historically deposited, more highly contaminated material. The absolute metal content in the sediment is strongly dominated by the regional grain size distribution. Higher contents are observed in regions with high silt content than in sandy regions. The reason is the higher affinity of the fine sediment content for the adsorption of metals. Metals accumulate mainly in the fine grain fraction.

Especially the elements copper, cadmium and nickel are found in most regions of the German EEZ at low levels or in the range of background concentrations. All heavy metals show elevated levels near the coast, and less pronounced levels along the East Frisian islands than along the North Frisian coast. These very distinct gradients, with increased contents near the coast and very low contents in the central North Sea, indicate a dominant role of freshwater inflows as a source of metal pollution. Added to this are possible discharges of metals from maritime shipping and the offshore industry (e.g. from corrosion protection measures), the additional contribution of which cannot be estimated at present. In detail, lead in the central North Sea in particular also shows significantly increased contents in the fine grain fraction. These are even higher than the values measured at stations near the coast. In contrast, the spatial distribution of the nickel contents in the fine grain fraction of the surface sediment is only characterised by very weakly pronounced gradients. The spatial structure does not allow any conclusions to be drawn about the main areas of stress. Although the values for Pb and Hg in the last MSRL Report (Status of German North Sea Waters 2018) are still above the threshold values, heavy metal pollution in the surface sediment of the EEZ has generally tended to decline (Cd, Cu, Hg) or show no clear trend (Ni, Pb, Zn) over the past 30 years.

Organic substances

Most of the organic pollutants are of anthropogenic origin. Some 2,000 mainly industrially produced substances are currently considered environmentally relevant (pollutants) because they are hazardous (toxic) or persistent in the environment (persistent) and/or may accumulate in the food chain (bioaccumulative). Since their properties can vary greatly, their distribution in the marine environment depends on a wide range of factors. In addition to input sources, input quantities and input pathways (directly via rivers, offshore industry or diffuse via the atmosphere), the physical and chemical properties of the pollutants and the dynamic-thermodynamic state of the ocean 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.

During its monitoring cruises, the BSH determines up to 120 different pollutants in the seawater, suspended solids and sediments. For most pollutants in the German Bight, the Elbe is the main input source. For this reason, the highest pollutant concentrations are generally found in the Elbe plume off the North Frisian coast, which generally decreases from the coast to the open sea. The gradients are particularly strong for non-polar substances, as these substances are predominantly adsorbed on suspended matter and are 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 introduced into the sea by atmospheric deposition or have direct sources in the sea (such as PAHs (polycyclic aromatic hydrocarbons), which can be introduced by the oil and gas industry and shipping. Therefore, land-based sources must also be taken into account in the distribution of these substances.

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

Radioactive substances (radionuclides)

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

Inherited waste

Possible inherited waste in the North Sea includes munitions remnants. In 2011, a federal-state working group published a basic report on munitions contamination in German marine waters. This is updated annually. According to official estimates, the seabed of the North and Baltic Seas holds 1.6 million tonnes of old ammunition and explosive ordnance of various types. A significant proportion of these ammunition dumps are from the Second World War. Even after the end of the war, large quantities of ammunition were sunk in the North Sea and Baltic Sea to disarm Germany. According to current knowledge, the explosive ordnance load in the German North Sea, especially in the coastal waters, is estimated at up to 1.3 million tonnes. The overall data availability is insufficient, so that it can be assumed that explosive ordnance is also to be expected in the area of the German EEZ (e.g. remnants of mine closures and combat operations). For the only known ammunition 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 ammunition dumped.

The ammunition remnants can basically silt up or be exposed on the seabed if the sediment properties are suitable. In addition, storm events or strong currents can lead to ammunition bodies in the sediment being exposed. This allows ammunition bodies to represent artificial hard substrates.

Current research indicates that the state of corrosion of munitions stored in the sea may be advanced. Whether and to what extent the marine environment is adversely affected by the release of toxic substances (e.g. explosives such as TNT) is the subject of current research and part of the work on implementing the decisions of the 93rd session of the UN General Assembly. Conference of Environment Ministers, TOP 27*.

The location of the known ammunition dump sites can be found on the official nautical charts and in the 2011 report (which also includes suspected areas for ammunition contaminated areas). The reports of the Federal-State 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 Status assessment of the seabed as a protected asset

2.2.4.1 Rarity and threat

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

2.2.4.2 Diversity and uniqueness

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. Besides the widely spread fine sands, medium and coarse sands are also frequently found. Residual sediments, gravel and stones occur as well. In the area of the Borkum and Norderney Reef Grounds and 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 uniqueness" is rated "medium".

2.2.4.3 Legacy impact

Natural factors

Climate change and sea level rise: The North Sea region has experienced dramatic climate change 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 its present level. Off the German North Sea coast, the sea level rose by 10 to 20 cm in the 20th century. Storms cause changes to the seabed. All sedimentary-dynamic processes can be traced back to meteorological and climatic processes, which are largely 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 are caused by the plate tectonic movements of the earth's crust and therefore occur over large areas. The analysis of earthquake frequency and intensity for the North Sea makes it clear that the German EEZ is not an earthquake-prone area. However, there are indications that about 8,000 years ago a seaquake triggered the submarine Storegga landslide in the Norwegian Sea, which subsequently caused a tsunami wave that spread across the entire North Sea.

Anthropogenic factors

Eutrophication: due to 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 share in the sediment composition (grain size distribution) can be neglected.

Fisheries: In the North Sea, bottom trawling uses otter trawls and beam trawls. Shearboards are used mainly in the northern North Sea and are pulled diagonally across the seabed. Their roller gear avoids getting caught on stones, but sometimes turns them over in the process. Beam trawls have been used mainly in the southern North Sea since the 1930s. Since the 1960s, there has been a sharp increase in beam trawl fishing, which has declined slightly over the last decade due to catch regulations and the decline in fish stocks. The skids of the beam trawlers leave tracks of 30 to 50 cm in width. In particular, their skids or chain nets have a greater impact 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 seabeds and up to 30 cm deep in soft silt (PASCHEN et al., 2000). In addition, the use of bottom trawls has the effect of smoothing the seabed by levelling ripple structures or small elevations. The distribution of the time taken by international trawling 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 ×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 and others only occasionally within several years (RUMOHR, 2003).

Sand and gravel extraction: In the North Sea EEZ, the extraction of gravel and sand is carried out with a suction trailer hopper dredging and usually leads to the formation of dm-deep furrows. With a maximum excavation depth of 2.5 m (including dredging tolerance), a residual thickness of the sediment worthy of extraction must be maintained in order to preserve the original substrate for repopulation. In the case of backfilling of the extraction structures, finer-grained sediments usually provide the filling material (ZEILER et al., 2004). In the subfields currently being mined in the EEZ, the extraction of the 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. As a result of this selective extraction, the sediments on the seabed are coarsened or refined in the extraction fields on the one hand, while on the other hand a furrowed or trough-shaped relief is retained to a certain extent because the recent hydrodynamic and sediment dynamic processes in the EEZ cannot lead to complete refilling with the original sediment due to the sediment supply. During sand and gravel extraction, cloudiness plumes are formed to varying degrees, which, depending on the proportion of silt and clay, mainly re-sediment on the seabed within a radius of about 500 m around the extraction point.

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

Submarine cables (telecommunications, power transmission): As a result of the infiltration process when cables are laid in the seabed, the water column becomes turbid as a result of sediment turbulence, but this turbidity 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 because of dilution effects and sedimentation of the stirred-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, stone fills are applied, which represent a locally limited hard substrate that is foreign to the location.

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 “A6-A” production facility as described in the area of installations 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 after several years of production in the vicinity of the A6-A platform, subsidence of the seabed will occur, which will depend on the geological conditions in the subsoil and will essentially be limited to the area of the deposit (approx. 15 km²).

Navigation: In the case of an anchor cast, the seabed is locally stirred up to a maximum depth of 1 m, depending on the size of the anchor and the type of sediment. Wrecks can silt up and become exposed again depending on the water depth as well as the type and amount of sediment present. Depending on their size, they influence the small-scale sediment dynamics by causing scouring in the vicinity or sedimentation of sands in the current shadow.

Anthropogenic factors affect the seabed in the following ways:

- Erosion
- Mixing
- Off-bottom suspension (resuspension)
- Material sorting
- Sealing
- Displacement and
- compaction.

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

The extent of anthropogenic legacy impact of the sediments and the morphological form inventory is decisive for the assessment of the aspect “legacy impact”. With regard to the criterion “legacy impact”, the protected asset seabed is assigned a medium level of impact because the existing legacy impact mentioned does exist 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 Ocean in the north. The oceanic climate of the North Sea - characterised by salinity and temperature - is largely determined by this northern opening to the Atlantic. In the south west, the Atlantic has less influence on the North Sea because 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 half-day tidal currents with the wind- and density-driven currents. In general, the North Sea is characterised by large-scale cyclonic, i.e. counterclockwise, circulation, with a strong inflow of Atlantic water at the northwestern edge and an outflow into the Atlantic Ocean via the Norwegian Gully. 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 between 1957 and 2001 by the BSH and the German Hydrographic Institute (DHI) (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 distance from the bottom) were determined for various areas in the Deutsche Bucht (Table 7). All time series with a length of at least 10 days and a water depth of more than 10 m were taken into consideration in this analysis. The objective of the analysis was to estimate the conditions in the open sea. The mean values are shown in Table 7 . The tidal 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)**
Mean amount	25 - 56 cm/s	16 - 42 cm/s
Vector means (residual current)	1 - 6 cm/s	1 - 3 cm/s
Tidal current	36 - 86 cm/s	26 - 73 cm/s

Figure 17 shows the flow conditions in the near-surface layer (3–12 m measurement depth) for various areas in the Deutsche Bucht. In the illustration, the values in area GB3 correspond to the (geological) sub-area "Borkum and Norderney Reef Grounds", GB2 corresponds to the sub-area "North of Helgoland" and GB1 corresponds to the sub-area "Elbe Glacial Valley and western plains".

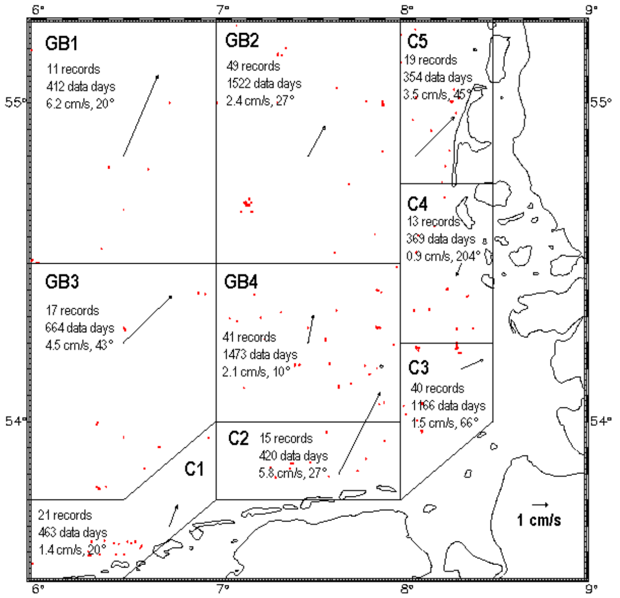


Figure 17: Vector mean of the flow in the near-surface layer (measuring depth 3 to 12 m). The measuring positions are marked with a red dot (BSH 2002).

2.3.2 Swell

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

During the climatological year (1950-1986), the highest wind speeds in the inner German Bight occur in November with 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, after which it drops rapidly and remains at a flat level of around 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 trend, based on monthly averages, is transferable to the height of the sea state. For the inner Deutsche Bucht, 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/south west and a second maximum from the east/south east (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 sea surface temperature (LOEWE et al. 2003). The seasonal minimum temperature in the German Bight usually occurs at the end of February/beginning of March, seasonal warming 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 Deutsche Bucht, 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 an average amplitude of 14.3 K, with the annual difference between maximum and minimum varying between 10 and 20 K. With the onset of seasonal warming and increased irradiation, thermal stratification sets in between the end of March and the beginning of May in the northwestern German Bight at water depths of over 25-30 m. With pronounced stratification, vertical gradients of up to 3 K/m are measured in the temperature jump layer (thermocline) between the warm surface layer and the colder seabed layer; the temperature difference between the layers can be up to 10 K (LOEWE et al. 2013). Flatter areas are generally mixed, even in summer, due to turbulent tidal currents and wind-induced turbulence. With the beginning of the first autumn storms, the German Bight is again thermally vertically mixed.

The time series of the annual mean spatial temperatures of the entire North Sea based on the temperature maps published weekly by the BSH since 1968 show that the course of the sea surface temperature (SST) is not characterised by a 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 North Sea SST fluctuated around a mean level of 10.8°C – ended with the cold winter of 2010 (Figure 18). After four significantly cooler years, the North Sea SST reached its highest annual mean of 11.4 °C in 2014.

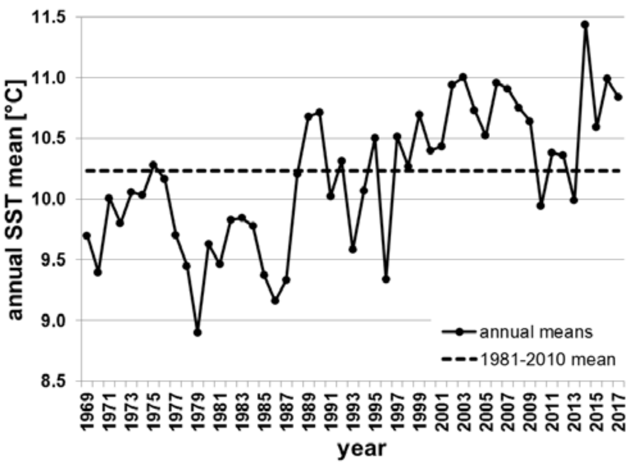


Figure 18: Annual average North Sea surface temperature for the years 1969-2017

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 set-up, forcing from the global climate model, and bias corrections, the different projections arrive at consistent results (KLEIN et al. 2018).

In contrast to the temperature, the salt content does not have a clearly pronounced annual cycle. Stable salinity stratifications occur in the North Sea in the estuaries of the major rivers and in the area of the Baltic outflow. Due to tidal turbulence, the fresh water discharge of the major rivers within the estuaries mixes with the coastal water at shallow depths, but at greater depths it stratifies over the North Sea water in the German Bight. The intensity of stratification varies depending on the annual course of river discharges, which in turn exhibit considerable interannual variability, e.g. due to high meltwater runoff in spring after heavy snow winters. For example, the salinity at Helgoland Reede is negatively correlated with the discharge volumes of the Elbe. This shows that freshwater inputs cause a significantly reduced salinity near the surface 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 Deutsche Bucht.

Since 1873 the salinity measurements of Helgoland Reede have been available, since about 1980 also the data at the positions of the former lightships, which were at least partly replaced by automated measuring systems later. The relocation of lightship positions and methodological problems, also in 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 mean 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. Projections of the future development of salinity in the German EEZ currently differ widely in terms of temporal development and spatial patterns. 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 in early winter is often so large that ice can only form very rarely. The open sea area off the North and East Frisian islands is ice-free in two thirds of all winters. On average over many years, the ice edge extends right behind the islands and into the outer estuaries of the Elbe and Weser. In normal winters, ice occurs on 17 to 23 days in the protected inner fairways in the North Frisian Wadden area, and only on 2 to 5 days in the open fairways - similar to the East Frisian Wadden area.

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

2.3.5 Fronts

Fronts in the sea are high-energy mesoscale structures (of the order of a few tens of kilometres to a few hundred kilometres) which have a major impact on the local movement dynamics of the water, on biology and ecology and - due to their ability to bring CO_2 to greater depths - also on the climate. In the coastal areas of the North Sea, especially off the German, Dutch and English coasts, the so-called river plume fronts with strong horizontal salinity and suspended matter gradients are located between the freshwater input area of the major continental rivers and the continental coastal waters of the North Sea. These fronts are not static formations 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 rivers 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. During the period of seasonal stratification (approx. from the end of March to September), the tidal mixing fronts, which mark the transition area between the thermally stratified deep water of the open North Sea and the shallower, vertically mixed area due to wind and tidal friction, are located approximately in the area of the 30 m depth line. Because of the 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 to 2011 and constructed 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. The strength of the spatial gradient generally increases towards the coast.

Fronts are characterised by significantly increased biological activity; and adjacent areas play a key role in the marine ecosystem. They influence ecosystem components at all stages – either directly or as a cascading process through the food chain (ICES 2006). Vertical transport on fronts brings nutrients into the euphotic zone, thereby increasing biological productivity. The increased biological activity on fronts, due to the high availability and effective use of nutrients, results in increased atmospheric CO_2 binding and transport to deeper layers. The outflow of these Co2-enriched$_2$-enriched water masses into the open ocean is referred to as “shelf sea pumping” and is an essential process for the uptake of atmospheric CO_2 by the world ocean. The North Sea is a CO_2 sink in large parts all year round, with the exception of the southern areas in the summer months. Over 90% of the CO_2 absorbed from the atmosphere is exported to the North Atlantic.

2.3.6 Suspended solids and turbidity

The term "suspended matter" refers to all particles suspended in seawater with a diameter >0.4 µm. Suspended matter consists of mineral and/or organic material. The proportion of organic suspended matter is strongly dependent on the season. The highest values occur during plankton blooms in early summer. During stormy weather conditions and the resulting high waves, the suspended matter content in the entire water column increases strongly due to the swirling up of silty-sandy bottom sediments. This is where the swell has the greatest effect. When hurricane lows pass through the German Bight, increases in the suspended matter content of up to ten times the normal values are easily possible. As water samples cannot be taken during extreme storm conditions, corresponding estimates are derived from the records of anchored turbidimeters. If one considers the temporal variability of the suspended sediment content at a fixed position, there is always a distinct half-day tidal signal. Ebb and flood currents transport the water in the German Bight on average about 10 nautical miles from or 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 southeast coast of England.

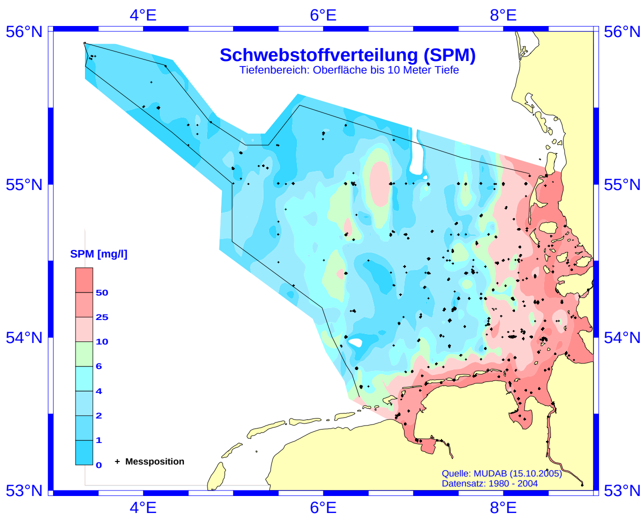


Figure 19: Mean suspended matter distribution (SPM) for the German North Sea.

In Figure 19, a mean suspended sediment distribution for the Deutsche Bucht is shown. The graph is based on all SPM values stored in the Marine Environmental Database (MUDAB) as of 15 October 15 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 in weather conditions in which research vessels are still operational. Difficult weather conditions are therefore not reflected in the average values shown here. In Figure 19, mean values of around 50 mg/l and extreme values of > 150 mg/l are measured in the mudflat areas landward of the East and North Frisian Islands and in the large estuaries. Further seawards, the values quickly decrease to a range between 1 and 4 mg/l. Slightly east of 6° E, there is an area of increased suspended sediment. The lowest SPM mean values around 1.5 mg/l are found in the north-western fringe of the EEZ and over the sandy areas between Borkum Riffgrund and the Elbe-Urstromtal.

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 essential for marine life. They are vital substances for the formation of phytoplankton (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 in the 1970s and 1980s due to extremely high nutrient inputs caused by industry, transport and agriculture, leads to a high accumulation of nutrients in seawater and thus to eutrophication. This still 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 beds, shifts in the species spectrum and oxygen deficiency near the seabed.

To monitor nutrients and oxygen levels in the German Bight, the BSH carries out several monitoring cruises per year. The nutrient concentrations show a typical annual cycle, with high concentrations in winter and low concentrations in the summer months. All nutrients show similar distribution structures. A gradual decrease in concentrations can be observed from the river estuary towards the open sea. The highest concentrations are measured in the Elbe tributary area and in coastal regions. The nutrient input* from the Elbe is clearly visible here (Figure 20).

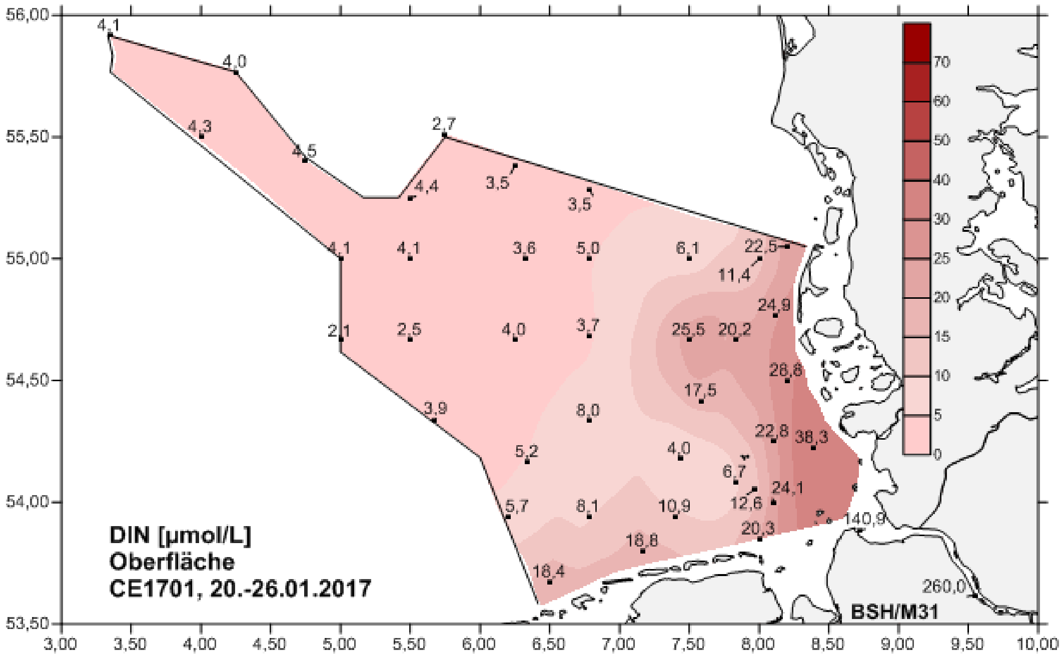


Figure 20: Distribution pattern of soluble inorganic nitrogen compounds (DIN).

Thanks to measures such as the expansion of wastewater 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 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 German North Sea waters) are classified as eutrophic in the 2006-2014 assessment period (Brockmann et al. 2017). Only in the outer German Bight (Duck's Bill) a good environmental status was achieved (6% of German North Sea waters). This assessment serves as the basis for the follow-up assessment under the

EU MSFD, so that a good environmental status under MSFD continues to fall short of descriptor 5 (eutrophication) (BMU 2018).

2.3.7.2 Metals

Metals occur naturally in the environment. The detection of metals in the environment is therefore in no way necessarily to be regarded as pollution. In addition to the naturally occurring element contents, human activities sometimes mobilise, transport, partially transform and re-enrich 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 anthropogenically induced metal signal in marine ecosystems are the run-off of contaminated freshwater masses via the continental river systems, the transport of pollutants via the atmosphere and the interrelationship with the sediment. Other inputs are caused by offshore activities, such as exploration for raw materials and extraction and dumping of dredged material.

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

Similar to the nutrients, some metals in the dissolved fraction show periodic seasonal variations in concentration. This seasonal profile corresponds roughly to the biological growth and remineralisation cycle, as it is also the case for the nutrient contents dissolved in seawater.

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

2.3.7.3 Organic substances

The BSH currently determines up to 120 different pollutants in the seawater, suspended solids and sediments during its monitoring cruises. As the Elbe is the main source of most pollutants in the German Bight, the highest pollutant concentrations are generally found in the Elbe plume off the North Frisian coast, which generally decreases in the open sea. The gradients for non-polar substances are particularly strong, as these substances are mainly 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. Water pollution 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 in the water phase observed.

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

According to current knowledge, the observed concentrations of most pollutants in seawater do not pose any immediate threat to the marine ecosystem. An exception is the pollution caused by tributyltin (TBT), which was formerly used in marine paints and whose concentration near the coast partly reaches the biological threshold. Furthermore, seabirds and seals can be damaged by oil films floating on the water surface as a result of acute oil spills. 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 enhanced by synergy effects.

2.3.7.4 Radioactive substances (radionuclides)

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

2.4 Plankton

Plankton includes all organisms that drift 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.

2.4.1 Data situation

For plankton, only a few monitoring programmes exist. Previous findings on the spatial and temporal variability of phyto- and zooplankton come from research programmes, a few long-term studies and ecosystem modelling. Remote sensing has also contributed significantly to improving data availability in recent years. Since 1932, a valuable long-term series has been provided 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). Approximately 450 different phyto- and zooplankton taxa have been identified through the CPR surveys, and more than 100 phytoplankton species have been identified in the North Sea (EDWARDS et al. 2005).

The most important data source for the Deutsche Bucht 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, studies of nutrient concentrations with simultaneous recording of temperature, salinity and oxygen are carried out every working day. Since 1967, the phytoplankton biomass has been determined.

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

There is a lack of such long-term series in the German EEZ. Only in the years 2008 to 2011, plankton (phyto- and mesozooplankton) was investigated at 12 selected stations in the German EEZ by the Leibniz Institute for Baltic Sea Research Warnemünde (IOW) on behalf of the BSH within the framework of 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 information from the four-year investigations of the IOW. It should be noted that Helgoland is not representative for the EEZ in terms of associated communities of hydrography and phytoplankton. In addition, zooplankton samples were collected and analysed from the FINO1 research platform in the area of the EEZ between March 2003 and December 2004 (OREJAS et al. 2005). The hydrographic conditions in this area of the EEZ vary considerably from those in the Helgoland Reede, in particular due to water depth and the prevailing currents. However, a pronounced variability in succession, as observed 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 the marine food chains and comprises small organisms, mostly up to 200 µm in size, which are taxonomically classified as belonging to the plant kingdom. They are micro-algae, usually consisting of a single cell or capable of forming 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 micro-organisms that can feed heterotrophically, i.e. from other micro-organisms. There are also 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 the phytoplankton, bacteria, fungi, and such organisms that are closer to the animal kingdom because of 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 (Bacillariophyta),
- dinoflagellates or flagellate algae (Dinophyceae) and
- microalgae or microflagellates of different taxonomic groups.

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

Phytoplankton growth in the German Bight shows fixed patterns during the year. In spatial terms, spring growth and thus algal bloom (masses of algae) only begin in the areas far from the coast, i.e. in the outer part of the German EEZ. From year to year, different species of diatoms are responsible for the spring algal bloom. *Thalassiosira rotula* forms spring algal flowers particularly frequently (VAN BEUSEKOM et al. 2003).

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

The spatial distribution of the phytoplankton depends primarily on the physical processes in the pelagial. Hydrographic conditions, in particular temperature, salinity, light, currents, wind, turbidity, fronts and tides, influence the occurrence and species diversity of the phytoplankton. The North Sea can roughly be divided into two areas that are fundamentally different for the occurrence of plankton: The area with a water body that is mixed throughout the year and the area with strong stratification (vertical stratification) of the water body. As a rule, these areas also have different nutrient concentrations. The encounter of mixed and stratified water masses is referred to as 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 weather conditions, freshwater input from rivers, 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 waters 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 part of the Schleswig-Holstein coastal waters off Sylt. This is also reflected in phytoplankton growth and chlorophylla concentrations (VAN BEUSEKOM et al. 2005).

A spatially sharp delineation of habitat types is therefore only possible to a very limited extent for phytoplankton, in contrast to e.g. benthos. The spatial and temporal distribution of microplankton in the Deutsche Bucht 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 displacement of these main water masses can influence the temporal and spatial development of the phytoplankton. During biological monitoring, 144 taxa were identified in 2010, and 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 years of the study (WASMUND et al. 2012). In 2011, the species *Cyclotella choctawhatcheeana* was probably spotted for the first time, while the otherwise often frequent species *Thalassiosira pacifica, Proboscia indica, Planktolyngbya limnetica, Coscinodiscus granii,* and *Prorocentrum minimum* were no longer spotted 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. In the marine ecosystem, zooplankton plays a central role: on 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. Eating away* or 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. Maximum abundances are generally reached in the summer months. The succession of zooplankton 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 staggered occurrence of succession and abundance of species leads to the interruption of food chains. In particular, temporal displacement, so-called trophic mismatch, results in food shortages at different developmental stages of organisms, with effects on the population level.

Zooplankton is divided into, based on the organisms' life strategies

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

The transport and distribution of larvae are of particular significance for the spatial occurrence and population development of both nektonic and benthic species. The distribution of larvae 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 determined within the scope of biological monitoring, with arthropods being the most common group with 80 taxa, followed by Cnidaria with 27 taxa, Polychaeta with 15 and Echinodermata larvae with 9 taxa. The total number of taxa 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 21). This observation is accompanied by the 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 pattern typical for estuaries. The values increase with increasing distance from the station near Helgoland, which is closest to the Elbe estuary, towards the central North Sea. This experience was already gained in the first reporting year, 2008. The result was supported by the changing copepod composition at the time. According to this, 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; arthropods were also the most common group (WASMUND et al. 2012).

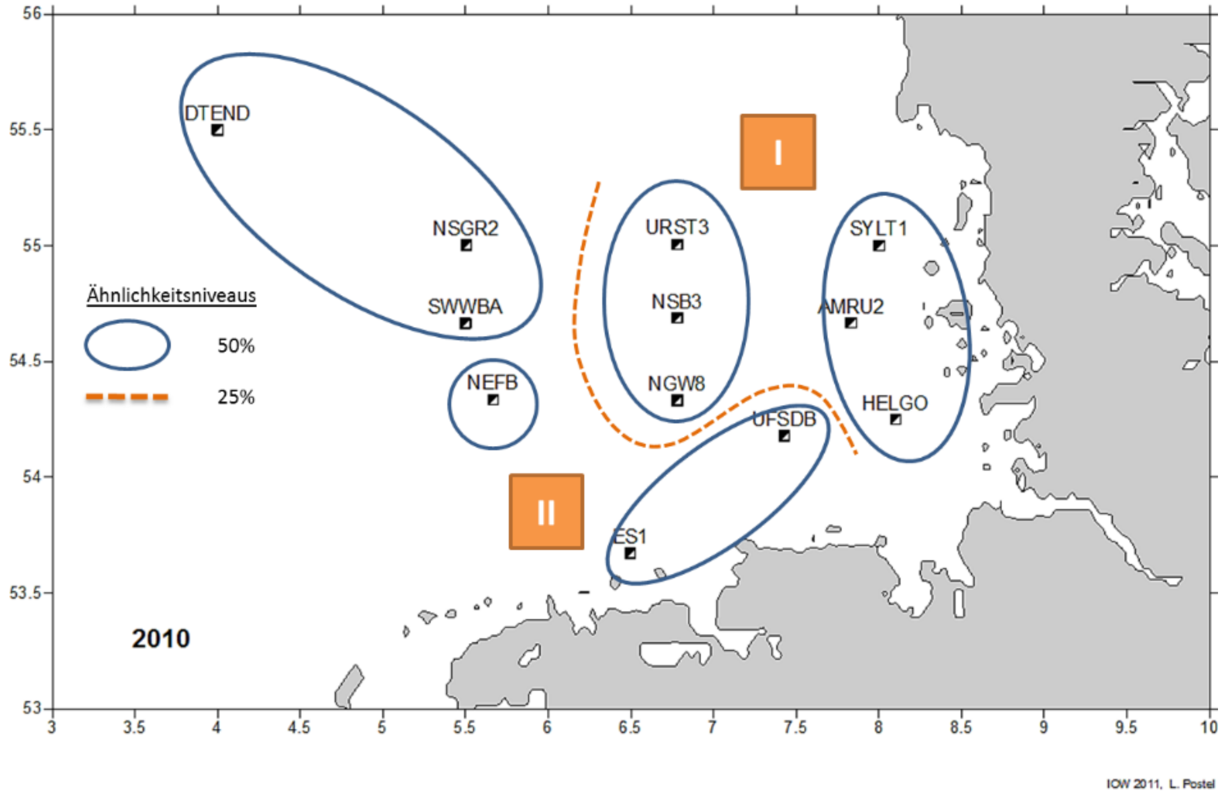


Figure 21: Spatial distribution of mesozooplankton communities according to cluster analysis based on the abundances of all taxa and their developmental stages in the German EEZ 2010 (WASMUND et al. 2011).

2.4.4 Status assessment of the plankton

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

The evaluation of the **phytoplankton data** of the Helgoland Reede shows a significant increase in biomass since the beginning of the records. This increasing trend in biomass seems to be related to the development of flagellates. For the area of the Deutsche Bucht, 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.

In addition to natural variability, these changes may be related to anthropogenic influences such as eutrophication and, 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 investigations have been carried out in this area, it remains unclear to what extent eutrophication, climate change, or simply natural variability contribute to changes in phytoplankton (EDWARDS & RICHARDSON 2004).

Increasingly, non-native species are also influencing succession. The number of alien species that spread in the North Sea for anthropogenic reasons has increased significantly in recent years. Alien species are introduced via ballast water from ships 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 ruled out. Throughout the North Sea, 17 non-indigenous phytoplankton species have been detected in samples (GOLLASCH & TUENTE 2004). Some of the non-native phytoplankton species are now developing pronounced algal blooms in the German coastal waters and the North Sea EEZ. For example, the non-native thermophile diatom species *Coscinodiscus wailesii* has slowly established itself in the German Bight 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 have correlated the observed 1.13 °C increase in water temperature between 1962 and 2002 with the mean diatom day (MDD), a calculated parameter of the diatom occurrence. It was shown that the temperature increase in the above mentioned period of 40 years 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 aforementioned temporal shift or delay in phytoplankton succession (WILTSHIRE & MANLY 2004), a possible species shift 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 water bodies and for the occurrence and stocks of fish, marine mammals and seabirds. Thus, the reduced abundance of diatoms in favour of small flagellates could have a negative impact on the food chain (VON WESTERNHAGEN & DETHLEFSEN 2003), because *C. wailesii*, which is now highly abundant in the Deutsche Bucht, is not eaten by primary consumers. Changes in the seasonal growth of phytoplankton can also lead to trophic mismatch within the marine food chains: a delay in diatom growth can affect the growth of primary consumers.

Under certain conditions, phytoplankton can pose a threat 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.

A creeping change since the early 1990s can also be demonstrated for **zooplankton.** For example, 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 decreased significantly. In contrast, meroplankton has increased (LINDLEY & BATTEN 2002). The proportion of echinoderms 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 mainly with changes in water temperature. However, the changes in seasonal development vary 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 been extended overall.

According to HAYS et al. (2005), climate changes have particularly affected distribution limits of species and groups of the North Sea marine ecosystem. For example, zooplankton associations of warm-water species in the Northeast Atlantic have shifted their distribution almost 1,000 km northwards. In contrast, the areas of cold water associations have decreased. In addition, climate changes have impacts on the seasonal occurrence of abundance maxima of different groups. For example, the copepod *Calanus finmarchicus* reaches the abundance maximum 11 days earlier, while its main food, the diatom species *Rhizosolenia alata* reaches its concentration maximum even 33 days earlier and the dinoflagellate species *Ceratium tripos* 27 days earlier. This delayed stock development can have consequences for the entire marine food chain. EDWARDS & RICHARDSON (2004) even suggest a particular threat to temperate marine ecosystems because of 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 source). 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 considerably in terms of association or group and seasonality.

2.5 Biotopes

According to VON NORDHEIM & MERCK (1995), a marine biotope is a characteristic, typified marine habitat. With its ecological conditions, a marine biotope offers largely uniform conditions for biotic communities in the sea that differ from other types. Typification includes abiotic (e.g.

moisture, nutrient content) and biotic features (occurrence of certain vegetation types and structures, plant communities, animal species).

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

2.5.1 Data situation

The distribution of sandbanks and reefs in the German North Sea EEZ is widely known. However, there is currently no comprehensive mapping of the distribution of biotopes in the North Sea EEZ, so that the occurrence of other marine biotopes cannot be adequately represented at present. Based on information from the BfN database LANIS Habitat Mare, a spatial distribution pattern of higher-level biotopes was created in accordance with FINCK et al. (2017) (Figure 22). However, on this basis, it is not possible to represent sites of marine biotopes in a sufficiently scientifically reliable way. A detailed and comprehensive mapping of marine biotopes in the EEZ is currently being prepared as part of ongoing BfN R&D projects.

As part of the procedures for the COBRAcable and NordLink cross-border cables (interconnectors), detailed investigations of the biotopes located in the vicinity of the planned cable routes were carried out, particularly in the area of the Borkum Reef Ground and the Sylt Outer Reef. These findings on the occurrence of protected biotopes are being used in current procedures for route planning that is as environmentally friendly as possible. In addition to information from environmental impact assessments, 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).

Natural biotope complexes ("mosaics"), such as the residual sediment deposits which occur mainly on the eastern slope of the Elbe Glacial Valley (Sylt Outer Reef) and on the Borkum Reef Ground, are of particular significance from a nature conservation perspective. These biotopes are associated with gravel fields, coarse, medium and fine sand areas, and even sometimes in small sinks, silt sandy substrates (usually only a thin layer of silt, which is remobilised again 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 redeposited by swell in large areas (especially with fine and medium sands); the fauna living there can thus be very variable (RACHOR & GERLACH 1978). Small rock fields can be so affected by sand movements (over-sanding, exposure) that long-lived reef communities cannot persist.

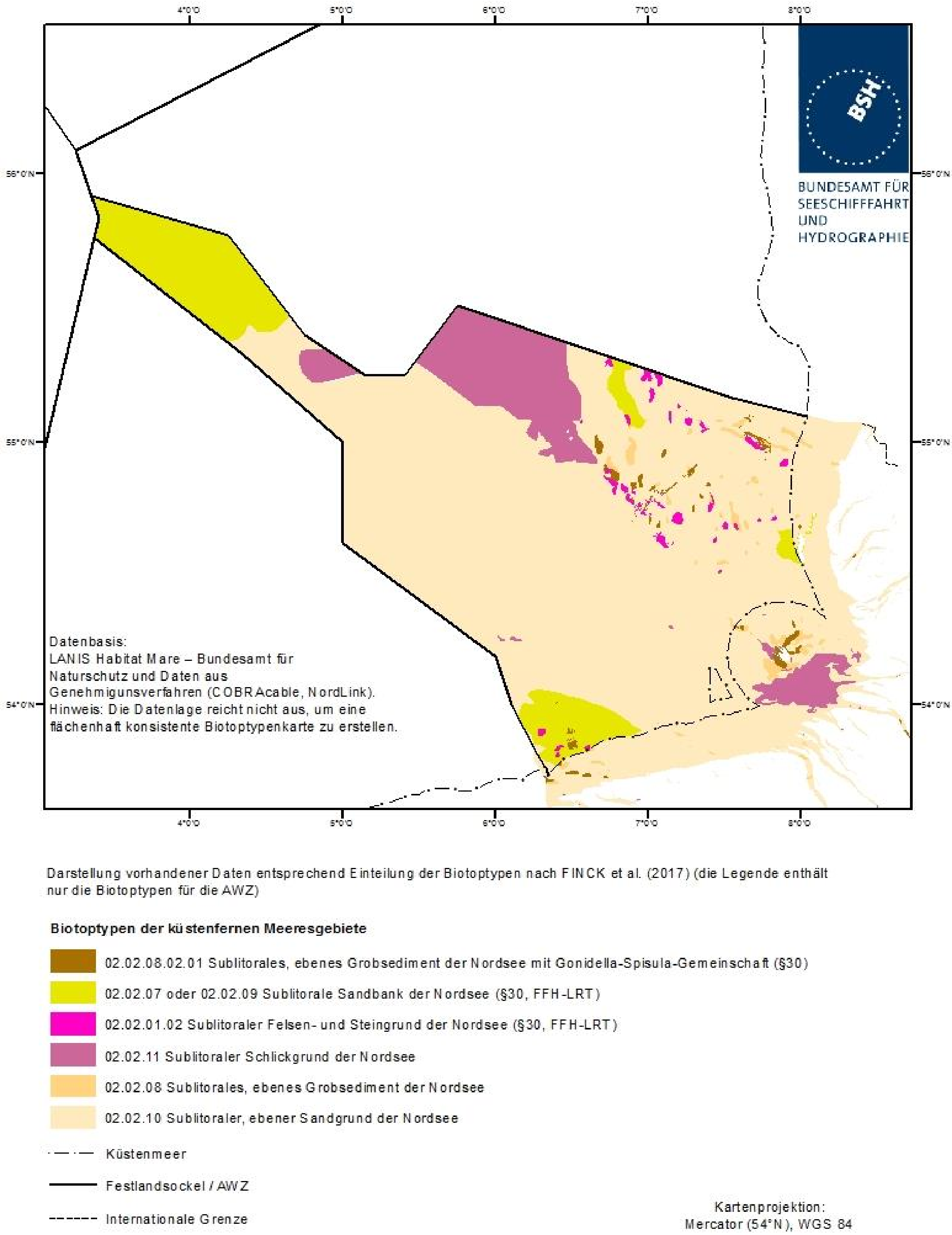


Figure 22: Map of the biotopes in the German North Sea that can be defined on the basis of existing data.

2.5.2 Legally protected marine biotopes in accordance with Section 30 BNatSchG and FFH habitat types

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

A number of marine biotopes are subject to direct protection under federal law according to Section 30 BNatSchG. Section 30, paragraph 2 BNatSchG generally prohibits actions that may cause destruction or other significant adverse effects on the listed biotopes. This does not require the designation of a protected area. This protection was extended to the EEZ with the amendment of the BNatSchG in 2010. In the North Sea EEZ, the following four marine and coastal biotopes are subject to statutory biotope protection under section 30 subsection 2 No. 6 BNatSchG: Reefs (also FFH-LRT), sublittoral sandbanks (also FFH-LRT), species-rich gravel, coarse sand, and shell layers as well as seapen and burrowing megafauna communities. The biotope “seagrass meadows and other marine macrophyte stands”, which is also protected, does not occur in the EEZ of the North Sea.

2.5.2.1 Reefs

The LRT 1170 "Reefs" according to the Habitats Directive is defined as follows: "Reefs can be either biogenic adhesions or of geogenic origin. These are hard substrates on firm and soft ground that rise from the seabed in the sublittoral and littoral zones. Reefs can promote the proliferation of benthic communities of algae and animal species as well as adhesions of coral formations" (DOC.HAB. 06-09/03). The hard substrate includes rocks (including soft rocks such as chalk cliffs) as well as boulders. The “BfN Mapping Guidance for “Reefs” in the German Exclusive Economic Zone (EEZ)”(BFN 2018) has been published since 9 July 2018; however, it has not yet been applied in the projects.

In the view of the BfN, such reefs and reef-like structures are found in some areas of the North Sea EEZ. In particular, areas around the Borkum Reef Ground, the eastern slope of theElbe Glacial Valley, and the Helgoland Stone Ground. However, there are currently no mapping instructions for the FHH-LRT "Reefs".

For the areas of the Sylt Outer Reef and the Borkum Reef Ground, current knowledge about the occurrence of the LRT "Reefs" in the area of the planned cable route COBRAcable is available. For the survey of the biotope “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, designates "sandbanks with only weak permanent inundation by seawater" and is defined as follows: "Sandbanks are elevated, elongated, rounded or irregular topographical features, which are constantly flooded by water and are predominantly surrounded by deeper waters. They consist mainly of sandy sediments, but may also contain coarse rock and stone fragments or smaller grain sizes, including silt. Banks on which sandy sediments occur as a layer over hard substrate are classified as sandbanks if the biota living in them depend on sand rather than hard substrate for life”. (DOC.HAB. 06-09/03).

From a nature conservation perspective, several sandbanks worthy of protection have been identified in the German North Sea EEZ. Large sandbanks are Dogger Bank and the somewhat smaller Amrumbank. From a nature conservation perspective, the Borkum Reef Ground is an example of a sandbank with stone fields or stony and gravelly areas as reef-like structures. In several BfN study areas, typical sandbank habitats were found which develop depending on the sediment type (fine, medium, coarse sand) and water depth. Areas in which different biocoenoses alternately occur side by side are particularly worthy of protection. For these reasons, large areas of the identified sandbanks have been protected by the FFH area notifications "Dogger Bank" (DE 1003-301), "Sylt Outer Reef" (DE 1209-301) and "Borkum Reef Ground" (DE 2104-301) and, in the meantime, also by the legal Regulation of 22 September 2017 establishing the "Sylt Outer Reef - Eastern German Bight" nature conservation area, the legal regulation of 22 September 2017 establishing the "Dogger Bank" nature conservation area and the legal regulation of 22 September 2017 establishing the "Borkum Reef Ground" nature conservation area in the North Sea EEZ. There are currently no mapping instructions for the FFH-LRT "Sandbanks with only weak permanent inundation by seawater".

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

This biotope includes species-rich pure or mixed sublittoral occurrences of gravel, coarse sand, or shell layers of the seabed, which are colonised by a specific endofauna (e.g. sand gap fauna) and macrozoobenthos community, irrespective of their large-scale location. These sediments are colonised in the North Sea by a macrozoobenthos community that is richer in species than the corresponding middle sand types.

This biotope may be associated with the occurrence of stones or mixed substrates and the occurrence of mussel beds or occur in close proximity to the "Sandbank" and "Reef" biotopes. Reefs and species-rich gravel, coarse sand, and shingle beds regularly occur together. In the sublittoral of the North Sea, the biotope is usually colonised by the *Goniadella spisula* community. This can be identified by the occurrence 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 EEZ of the North Sea: the more species-rich one on coarse sand and gravel and the less species-poor one on coarse sandy medium sand. If stones occur in the area, a typical epibenthic macrofauna also occurs. In the North Sea, the species-rich expression, except in the area around Helgoland, generally occurs at depths greater than 20 m (ARMONIES 2010). The settlement of this biotope is spatially highly heterogeneous.

The biotope "Species-rich gravel, coarse sand, and shell layers in marine and coastal areas" generally occurs in relatively small-scale expressions throughout the North Sea. It is not found in the German North Sea in the Dogger Bank area 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 Reef Ground, current knowledge is available on the occurrence of species-rich gravel, coarse sand, and shell layers in the area of the COBRA cable cable route.

2.5.2.4 Silt bottoms with burrowing ground mega-fauna

The biotope “Silt bottoms with burrowing ground mega-fauna” is determined by the occurrence of sea pens (Pennatularia), which have a particularly high sensitivity to mechanical disturbance and damage. In addition to sea feathers, thebiotope is characterised by an increased density of digging crustaceans (especially *Nephrops norvegicus, Calocaris macandreae, Upogebia deltaura, Upogebia stellata, Callianassa subterranea*). Each digging species forms characteristic vein systems in the seabed. These create the conditions for oxygen-rich water to penetrate deep into the seabed, thus providing habitats for other species.

"Seapen and burrowing megafauna communities" occur in the North Sea and in 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-Urstromtal and the adjacent areas with fine-substrate sediments at depths of more than 15 metres. “There are currently no known occurrences of sea pens in the German North Sea” (BFN 2011b). Without the occurrence of this character species, there is also no evidence of the biotope "Seapen and burrowing megafauna communities".

As there has been no comprehensive mapping of the above-mentioned biotopes in the German North Sea to date, it is currently not possible to identify any specific areas in the North Sea EEZ where the biotopes "Species-rich gravel, coarse sand, and shell layers in coastal and marine areas" and "Seapen and burrowing megafauna communities" occur. In coordination with the BMU, the BfN has published a definition and mapping instructions for the survey of the biotopes species-rich gravel, coarse sand, and shingle beds* as well as silt bottoms with burrowing mega-fauna (BFN 2011a & b).

2.5.3 Status assessment

The stock assessment* of the biotopes occurring in the German marine area is based on the national protection status as well as the endangerment of these biotopes according to the Red List of Threat Biotopes of Germany FINCK et al. 2017). The aforementioned legally protected biotopes are of great importance in this context. In the North Sea, these biotopes are endangered above all by current or past nutrient and pollutant inputs (including wastewater discharge, oil pollution, dumping, waste and debris dumping), by fisheries in contact with the bottom, and possibly also by the effects of construction activities. Since bottom-contact fishing is largely excluded within the wind farms, a certain degree of recovery of the biotopes occurring in the wind energy areas can be expected.

2.5.3.1 Importance of wind energy areas for biotope types

Area EN1

In area N-1, the legally protected biotopes "Sublittoral sandbank" and "Species-rich gravel, coarse sand, and shell layers" occur. A northwestern extension of the 90,000 ha sandbank "Borkum Reef Ground" extends 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*” found in area EN1 are in part large-scale occurrences that occupy larger areas of the project areas “Borkum Riffgrund West 1”, “Borkum Riffgrund West 22 and “OWF West” (BIOCONSULT 2016b, 2017). In the opinion of the BfN, a larger site in the western part of the project area “Borkum Riffgrund West 2” is a biotope protected according to Section 30 BNatSchG. So far, not all known suspected areas in area EN1 have been investigated in accordance with the BfN mapping instructions (BFN 2011a).

The EN1 area is accorded high overall significance due to the extensive occurrence of the biotopes "Sublittoral sandbanks" and "Species-rich gravel, coarse sand, and shell layers".

Area EN2

A large part of the EN2 area is located on the sandbank "Borkum Reef Ground". South to southwest of the EN2 area there are occurrences of the legally protected biotopes "Reefs" and "Species-rich gravel, coarse sand, and shell layers, especially in the area of the "Borkum Reef Ground" nature conservation area. There are no known occurrences of these biotopes within the EN2 area.

The EN2 area is of high overall significance for biotopes due to the extensive occurrence of the "Sublittoral sandbank" biotope.

Area EN3

In the EN3 area, the near-surface sediments consist mainly of a fine to middle sandy cover layer, the upper decimetres of which are regularly displaced by hydrodynamic processes of the North Sea. Occurrences of legally protected biotopes are not known for a large part of the EN3 area. Only a small part of the area extends into the sandbank "Borkum Reef Ground", which has been designated by the BfN. According to BfN estimates, there is no evidence of qualitative-functional peculiarities of the biotope character for this part of the sandbank.

Due to the only slight overlap of the EN3 area with the "Borkum Reef Ground" sandbank and the otherwise predominantly homogeneous, fine- to middle-sand sedimentary conditions, the EN3 area as a whole is accorded a low significance and in the southwestern sub-area an average significance with regard to the protected asset biotopes.

Area EN4

In the EN4 area, there is as yet no evidence of the occurrence of legally protected biotopes (IBL 2016). The EN4 area is therefore of minor significance with regard to the protected asset biotopes.

Area EN5

Due to its location in the area of the Sylt Outer Reef, the EN5 area contains extensive occurrences of the legally protected biotopes and FFH-LRT "Reefs" and "Sublittoral sandbanks". In addition, the legally protected biotope "Species-rich gravel, coarse sand, and shell layers" occurs in the EN5 area. The sandbank in the western part of the EN5 area designated by BfN 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 shell layers", the EN5 area is of great importance with regard to biotopes.

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

The occurrence of legally protected biotopes and FFH-LRTs in 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 occurrence of sediments with partly high silt content and species of burrowing bottom mega-fauna (Chapter 2.6), the legally protected biotope “Silt bottoms with burrowing bottom mega-fauna” can excluded because of the absence of sea pens. Consequently, areas EN6 to EN13 are of little significance for the protected asset biotopes.

Areas EN14 through EN19

For the areas EN14 to EN18, there is little knowledge of biotope occurrences. Area 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 bound to substrate surfaces or living in soft substrates at the bottom of water bodies. 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 micro-organisms 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. Zoo benthos are animals that live predominantly in or on the ground. These organisms largely restrict their activities to the border area between the free water and the uppermost seabed layer, which is usually only a few decimetres in the vertical plane.

In the case of the so-called holobenthic species, all phases of life 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 tied to this ecosystem) (Tardent 1993). These spread mostly via planktonic larvae. In older stages, on the other hand, the ability to change location is reduced. Overall, most representatives of the benthos are characterised by a lack of or limited mobility compared with those of the plankton and nekton. Therefore, because of its relative local stability, the seabed fauna can hardly evade natural and anthropogenic changes and pressures as a rule and is thus, in many cases, an indicator of changed environmental conditions (Rachor 1990a).

The North Sea seabed largely consists of sandy or silty sediments allowing the animals to penetrate the bottom. In addition to the epifauna living on the seabed surface, a typical infauna (endofauna) living in the seabed has therefore also developed. Micro-animals of less than 1 mm body size (micro- and meiofauna) make up the majority of these soil dwellers. However, better known than these tiny creatures are the larger animals, the macrofauna, and here especially the more localised forms such as annelids, mussels and snails, echinoderms, and various crustaceans (Rachor 1990a). Therefore, for practical reasons, the macrozoobenthos (animals > 1 mm) is investigated internationally as a proxy for the entire zoobenthos (Armonies & Asmus, 2002). The zoobenthos of the North Sea is composed of a large number of systematic groups and shows a wide variety of behaviour. Overall, this fauna is quite well investigated and therefore allows comparisons with conditions a few decades ago.

2.6.1 Data situation

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

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

KRÖNCKE (1985) and WESTERNHAGEN et al. (1986) investigated the influence of extremely low oxygen concentrations on the macrozoobenthos in the Deutsche Bucht and in Danish waters during the summers of 1981 to 1983. The investigations showed a decrease in species numbers and biomass and 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 the comparison of data sets from the Deutsche Bucht between 1923 and 1965–1966 carried out by STRIPP (1969 a/ b), no significant change in the benthic communities was detected compared with Hagmeier's investigations. NIERMANN (1990) compares the data of Hagmeier and Stripp 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, investigated the entire Deutsche Bucht and found an increase in biomass compared with earlier investigations. As possible reasons, they cite nutrient richness.

RACHOR (1990b) describes changes in macrozoobenthos communities on different sediment types as a result of eutrophication. According to these studies, sandy sediments are more affected by the input of organic material than silt. During investigations of the epibenthos of the Deutsche Bucht, REISE & BARTSCH (1990) discovered that the fauna was more diverse in the past than during their surveys. Further investigations show that fishing with heavy bottom gear leads to changes in benthic communities with a decline in long-lived and fragile species within the communities investigated (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, this study carried out analyses of the benthic communities, on the one hand on a large scale for the entire EEZ and on the other hand regionally on an area scale. In 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 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 to 2011 by GHODRATI SHOJAEI et al. (2016) confirmed that winter temperatures and the North Atlantic Oscillation (NAO) are the predominant environmental factors determining the temporal variability of macrozoobenthos in the Deutsche Bucht. 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 because of expected climate change suggests a northward shift and a high degree of habitat loss for a number of key species, especially for the southern North Sea, with potential 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 redistribution (ARMONIES 1999, 2000a, 2000b). Among anthropogenic impacts, in addition to nutrient and pollutant discharges, disturbance of the seabed surface by fishing is of particular importance (RACHOR et al., 1995). Fishing with bottom trawling can adversely affect the structure and trophic function of benthic communities (DANNHEIM et al. 2014b), even in sites that have already been heavily damaged (REISS et al. 2009).

The following natural classification of the German North Sea EEZ from a benthological perspective differs from the natural classification according to sedimentological criteria. Although the macrozoobenthos shows a strong link to 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 Deutsche Bucht 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 8 and graphically depicted in Figure 23, taking into consideration the hydro- and topography.

TheElbe Glacial Valley and - in the outer area - the Dogger Bank form the central guiding structures in the German North Sea EEZ. These are important, for example, for the networking of habitats, as stepping stones and as retreat areas. Dogger Bank is also a biogeographical divide between the northern and southern North Sea.

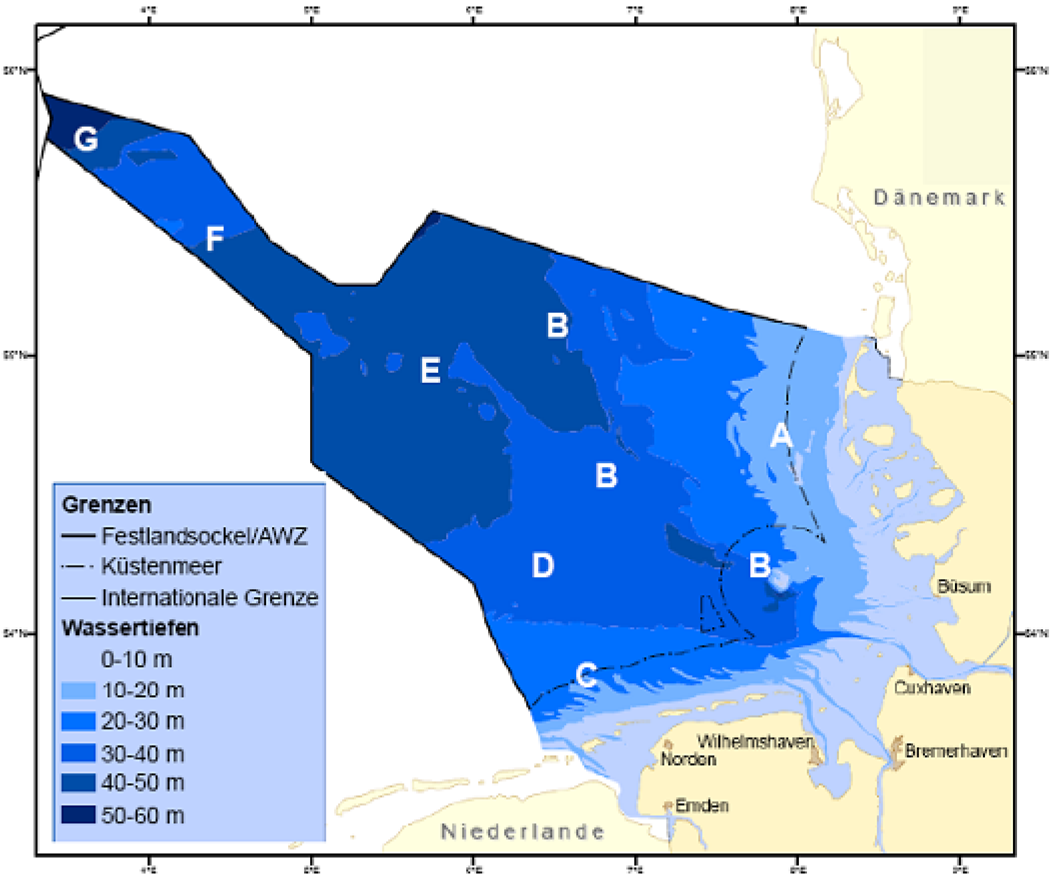


Figure 23: Natural area classification of the German EEZ of the North Sea according to RACHOR & NEHMER (2003), final report for BfN.

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

ABBRE-VIATON cf Figure 23	DESIGNATION	HYDROGRAPHY	TOPOGRA-PHY	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 of the major rivers; high nutrient concentration, higher pollutant concentration than in the rest of the EEZ; northward directed residual current (CCC)	from −10 bis −43 m	Heterogeneous sediment distribution from fine to coarse sand, isolated gravel and stone areas	primarily **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 Glacial Valley	Water bodies temporarily stratified seasonally, regionally with oxygen depletion; coastal water with lower salinity may lie above water with higher salinity	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 mega-fauna possible in parts; Nucula nitidosa communits in the near-shore silt and silty* sand areas
C	Southwestern German Bight (coastal East Frisian EEZ with Borkum Reef Ground)	inflow of Atlantic water from the Channel and the western North Sea; eastern current	from −20 bis −36 m	heterogeneous sediment distribution of fine to coarse sand, occasional gravel and individual stone deposits	primarily **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	Northwestern German Bight (offshore East Frisian EEZ)	under North Sea water influence; low east current	from −30 bis −40 m	Silty fine sand	**Amphiura filiformis community** (dominant species: Brittle star); drilling 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 Weiße Bank) to −50 m	Silty fine sand	**Amphiura filiformis community** (dominant species: Brittle star); drilling megafauna possible in some areas
F	Dogger Bank	on the slopes, formation of eddies and fronts; strong vertical mixing on the bank, water bodies rarely stratified	Depths from −29 to −40 m, shallowing to the W	Fine to middle sand	Offshore fine sand community **Bathyporeia-Tellina community**

ABBRE-VIATON cf Fig-ure 23	DESIGNATION	HYDROGRAPHY	TOPOGRA-PHY	SEDIMENT*	BENTHOS
G	Central North Sea north of Dogger Bank	Water regularly stratified in the summer months	Depths over −40 m	fine sands, in places boulder clay or clay	Benthic community of the central North Sea, Myriochele

*modified BSH

2.6.2.1 Current species spectrum of the North Sea EEZ

At present, a total of about 1,500 marine macrozoobenthos species are known to occur 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). Investigations on the benthos of the EEZ were carried out as part of the investigations of the R&D project "Survey and assessment of ecologically valuable habitats in the North Sea"(RACHOR & NEHMER 2003) in May/June 2000 using Van Veen gripper samples at 181 stations and with additional 79 beam trawl hauls. A total of 483 taxa (361 of which were identified by species) of endo- and epifauna including demersal fish were identified. The groups of polychaeta (polybristle) with 129 species, crustacea (crabs) with 101 species and mollusca (molluscs) with 66 species accounted for the largest share. A total of 336 macrozoobenthos invertebrate species were detected.

The range of species recorded by RACHOR & NEHMER (2003) can be supplemented by the investigations carried out as part of various offshore wind farm and submarine cable projects as well as additional AWI research projects. Based on a taxonomic harmonisation of this extensive benthic database, between 1997 and 2014, 573 species were recorded for the benthic infauna alone in the area of the German EEZ (DANNHEIM et al. 2016). This results in a total species count of invertebrate macrozoans in the area of the German EEZ of approximately 750 species. In the ranking of species diversity of individual large groups, the group of polychaeta is the richest in species, followed by crustaceans and molluscs.

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, species diversity ranged from 37 in the area of the North Frisian Islands to 121 in the Duck's Bill. Considering spring and autumn samples separately, the number of species in spring varied between 16 in the area of the North Frisian Islands and 90 in the Duck`s Bill. In autumn, 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, assessments for a total of 1,244 macrozoobenthos taxa have been carried out within the framework of the current Red List. According to this, 11.7% of all assessed taxa are endangered, and a further 16.5% of species are potentially endangered although probably stable on a large scale, but extremely rare. If the 3.9% of missing species are added (48 of the total of 49 missing species were found only in the area of Helgoland), 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 threatened 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 detected species are considered extinct (*Modiolula phaseolina* and *Ascidia virginea*). According to the latest findings, the detection of the sea squirt *Ascidia virginea* is considered a false positive. In accordance with the post-determination, this is probably the extremely rare (Red List Cat. R) species *Ascidiella scabra* (J. DANNHEIM personal communication, species list currently under revision).

The two species *Nucula nucleus* and *Spatangus purpureus are* classified as endangered (Red List cat. 1). Another seven species (*Buccinum undatum, Echiurus echiurus, Ensis enis, Modiolus modiolus, Sabellaria spinulosa, Spisula elliptica, Upogebia stellata*) are critically endangered (Red List cat. 2). Nine other species are classified as endangered (Red List Cat. 3). A total of 33 species are assumed to be endangered to an unknown extent (Red List Cat. G), 45 species are extremely rare (Red List Cat. R). In addition to these 98 Red List species, a further 17 species are on the early warning list. The taxonomic major groups with the highest number of Red List species are bivalves (Bivalvia, 30 species), polychaeta (26 species) and amphipods (20 species).

According to a recent study by DANNHEIM et al. (2016), the benthic species on the Red List 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 Doggerbank, the Sylter Außenriff and northwest of the Sylter Außenriff (Figure 24). 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 therefore does not differ significantly from the distribution patterns of the rest of the benthic fauna.

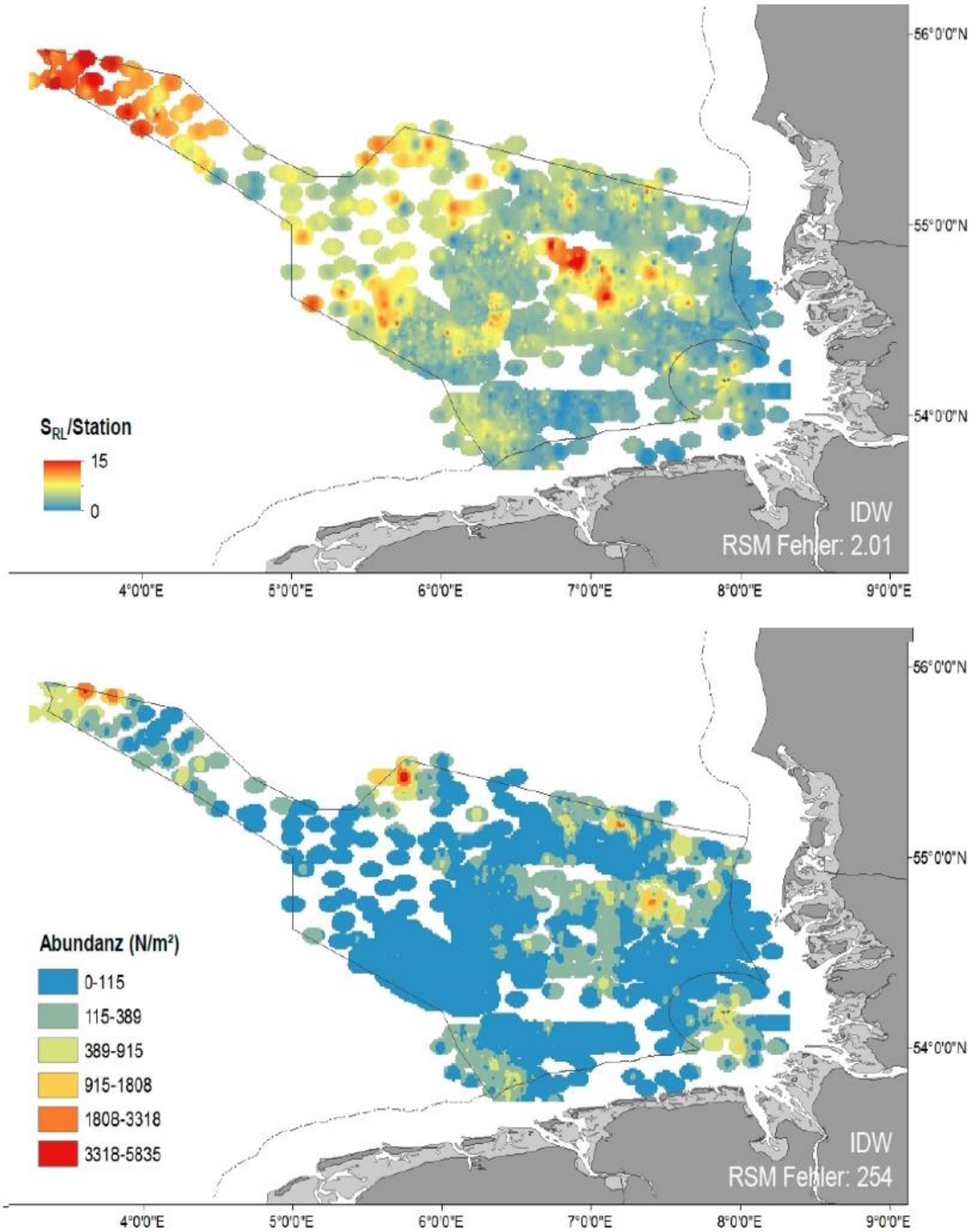


Figure 24: Number of species (top) and abundance (bottom) of Red List benthic species in the German EEZ (from DANNHEIM et al. 2016).

2.6.2.3 Symbiotic communities

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

The settlement areas of the macrozoobenthos recorded in 2000 with bottom grippers in the south-eastern North Sea (RACHOR & NEHMER 2003) are shown in simplified form in Figure 25. The largest areas in the EEZ are occupied by the *Amphiura filiformis*, *Tellina fabula* and *Nucula nitidosa* communities; the Dogger Bank is mainly home to the *Bathyporeia tellina* community.

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

The variants of the *Goniadella-Spisula* community, which are often associated with stone reefs and stone fields, occur in the area of Borkum Riffgrund and mainly east of the Elbe glacial valley. Larger stone accumulations provide a certain degree of protection from bottom fishing; however, these biotope mosaics are now threatened by gravel and sand mining.

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

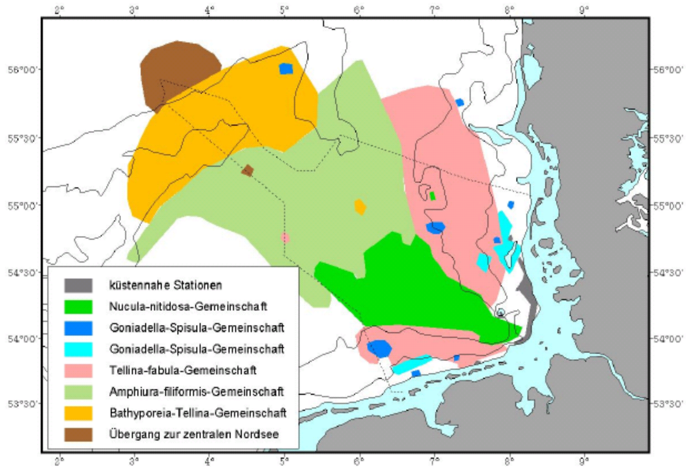


Figure 25: Settlement areas of the most important bottom-dwelling animal communities (macrozoobenthos, according to bottom gripper samples) in the German EEZ of the North Sea and adjacent areas (from RACHOR & NEHMER 2003, final report for BfN); in the area of the territorial waters, the representation 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; first on a large scale for the entire EEZ and second regionally on the scale of the areas.

For the benthic **epifauna**, six significantly different communities each were identified on a large-scale and regional scale (Figure 26. However, the identified associations are not clearly distinguishable spatial units, but rather reflect gradual changes in the abundance ratios between near-coastal and far-off 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* (sand sea star), *Crangon* spp. (shrimps), *Liocarcinus holsatus* (common swimming crab), *Ophiura ophiura* (large brittle star), *Ophiura albida* (small brittle star) and *Pagurus bernhardus* (hermit crab). Especially the communities near the coast are characterised by some dominant species (e.g. *Crangon* spp. and *Ophiura albida*), while the dominance is more balanced in the regions far from the coast. The more productive coastal regions also have higher abundances and biomass values than the more remote regions.

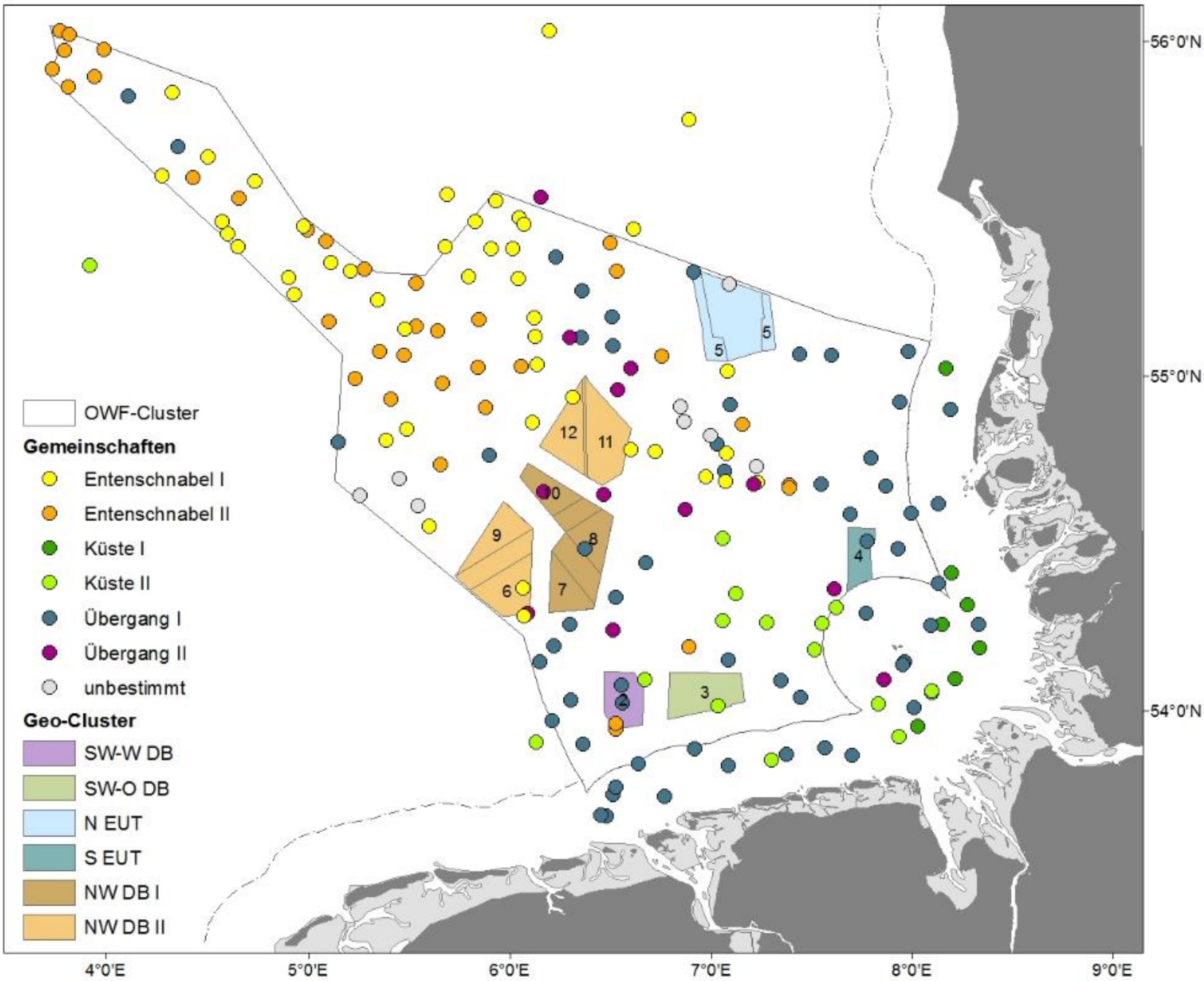


Figure 26: Large-scale communities and regional geo-clusters identified based on abundances of epifauna in the German EEZ of the North Sea (according to DANNHEIM et al. 2014a). SW-W DB = Western Southwestern German Bight, SW-O DB = Eastern Southwestern German Bight, N EUT = Northern Elbe Glacial Valley, S EUT = Southern Elbe Glacial Valley, NW DB I = Northwestern German Bight I, NW DB II = Northwestern 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 were confirmed (Figure 27). In addition to the established communities, seven other communities were identified; these are essentially gradual transitional communities between the established associations. In contrast to the epifauna, no clear gradients are discernible for the infauna as a function of distance from the coast. Rather, according to DANNHEIM et al. (2014a), sediment properties have the greatest influence on the composition of the infauna. This in turn requires a relatively high degree of small-scale variability in the faunistic structure of the infauna, especially in sedimentologically heterogeneous areas, such as the Amrum Bank and the Sylt Outer Reef.

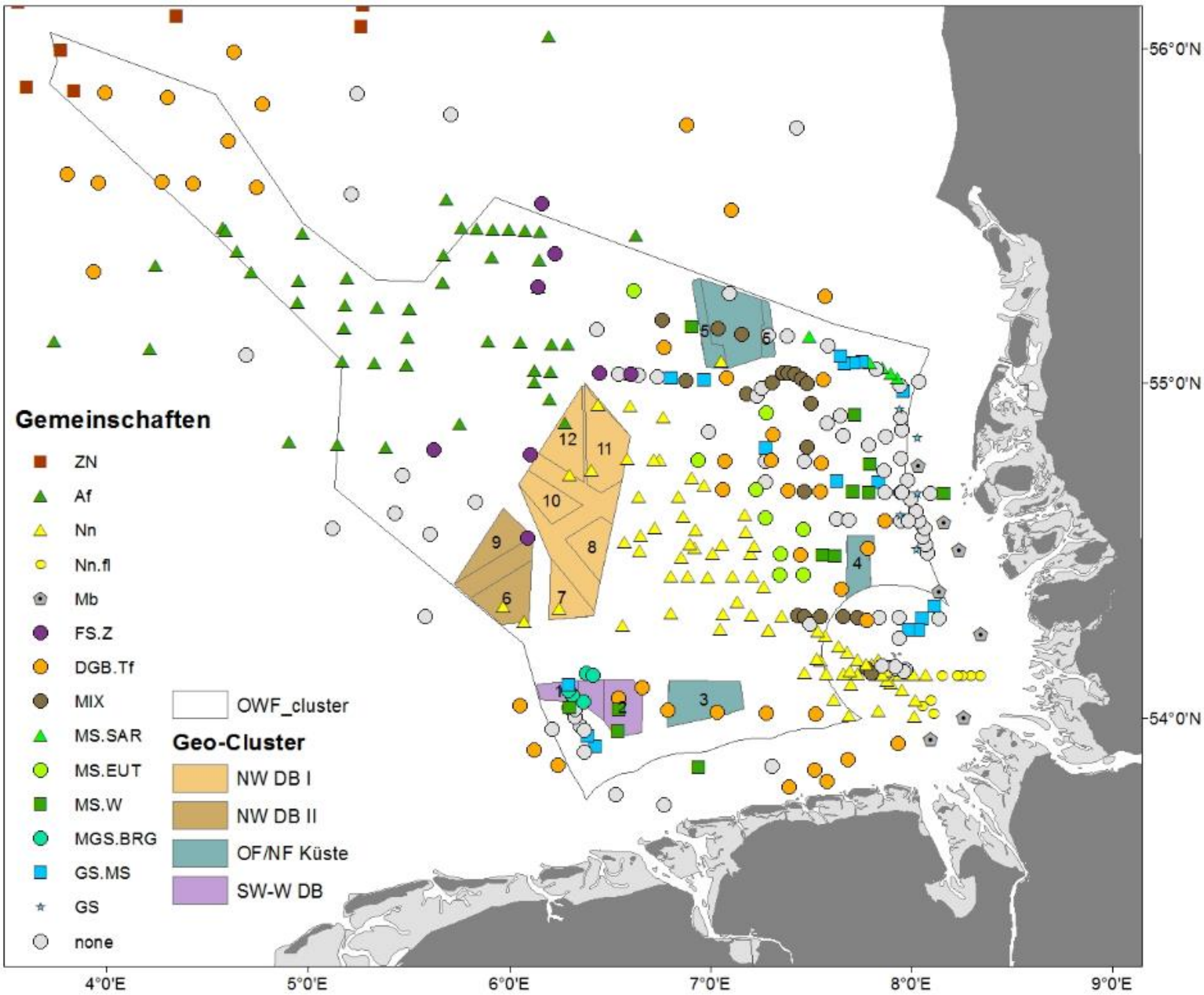


Figure 27: Large-scale communities and regional geo-clusters identified based on abundances of infauna in the German EEZ of the North Sea (according to DANNHEIM et al. 2014a). Cluster: ZN = Central North Sea, Af = Amphiura filiformis community, Nn = Nucula nitidosa community, Nn.fl = flat Nucula nitidosa community, Mb = Macoma balthica community, FS.Z = fine sand central, DBG.Tf = Dogger Bank/Tellina fabula community, MIX = heterogeneous sands, MS.SAR = middle sand Sylt Outer Reef, MS.EUT = middle sand Elbe Glacial Valley, MS.W = middle sand west, MGS.BRG = middle coarse sand Borkum Reef Ground, GS.MS = coarse sand middle sand, GS = Goniadella/Spisula middle coarse sand, none = not defined. Geo-cluster: SW-W DB = western southwestern German Bight, OF/NF coast = East Frisian/North Frisian coast, NW DB I, II = north-western German Bight I, II.

2.6.3 Status assessment of the protected asset benthos

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), the main influencing factors are demersal fishing, sand and gravel extraction, the introduction of alien species and eutrophication of the water body, and climate change.

Criterion: Rarity and threat

The number of rare or vulnerable species is taken into account. The rarity/endangerment of the stock can be assessed on the basis of the confirmed species on the Red List.

According to current studies, the macrozoobenthos of the North Sea EEZ is considered to be average due to the proven number of Red List species. 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 species are assigned to a Red List category. The 400 species represent over 30% of the total population.

In the recent investigations by DANNHEIM et al. (2016), 98 threatened or extremely rare Red List species were identified in the EEZ of the North Sea from 1997 to 2014; these represent approx. 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 a species thought to be extinct has now been proven to be a misidentification (J. DANNHEIM personal communication). In contrast,RACHOR et al. (2013) list 49 species in Red List Cat. 0 and eight in Red List Cat. 1. The individual consideration of the natural units defined by RACHOR & NEHMER (2003) does not lead to any deviating status assessment of the macrozoobenthos.

Criterion: Diversity and uniqueness

This criterion refers to the number of species and the composition of the 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 EEZ of the North Sea can be regarded as average with currently about 750 recorded macrozoobenthos species (excluding fish). 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 also do not show any special features because the main structuring natural factors for the composition of the macrozoobenthos in the Deutsche Bucht 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, its occurrence extends beyond the German EEZ. The *Myriochele* community joins* north of Doggerbank and is widespread outside the German EEZ (RACHOR et al. 1998). Overall, all the benthic communities found in the area are not considered to be of outstanding importance. According to KRÖNCKE (2004), the six benthic communities occurring 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; however, the individual species are also present in the other communities. Therefore, these communities could not be distinguished in terms of their value; instead, all communities had the same value.

Criterion: Legacy impacts

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 the assessment benchmark. Benthic communities can also be adversely affected through eutrophication. For other disturbance variables such as shipping traffic and pollutants, there is currently a lack of suitable measurement and detection methods to be able to include them in the assessment.

With regard to the pre-existing impacts criterion, the benthos deviates from its original state due to prior impacts (fisheries, eutrophication and pollutant inputs). Of particular note 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 corresponds to the status that would be expected without human uses (ARMONIES & ASMUS 2002).

In summary, the North Sea EEZ is not of major importance in terms of the benthic organisms inventory. The benthos of the North Sea EEZ is typical of the German North Sea and reflects in particular the sediment and depth conditions and the legacy impacts from anthropogenic influences.

2.6.3.1 Importance of sites 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 Deutsche Bucht) 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 27). 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 24). The variants of the *Goniadella spisula* community found in these areas are of high importance in terms of rarity and threat* because of the relatively high number of Red List species. In the more species-poor expression, this community is of medium importance in terms of diversity and uniqueness. However, it is of great importance in areas which are classified as "Species-rich gravel, coarse sand, and shell layers" under section 30 BNatSchG. The legacy impact of the *Goniadella spisula* community is low to medium because of 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.

Wind energy areas 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 communities found in these areas showed the highest abundances. Compared to all areas, the highest structural heterogeneity of the benthic communities was found in Area EN5, mainly because of 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 the EN3 area there is a transition 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 Area EN3 are neither rare nor threatened in the EEZ of the North Sea. Overall, the benthic communities can be assigned a low to medium importance because of an average species diversity and number of Red List species as well as the legacy impact by fishing.

Priority areas for wind energy EN6 and EN9

In the area of Areas EN6 and EN9, the geo-cluster NW DB II (Nordwestliche Deutsche Bucht II) was identified by DANNHEIM et al. (2014a). The biocoenosis occurring in these areas essentially corresponds to the *Amphiura filiformis association* with elements of the *Nucula nitidosa association*, which are added mainly in area EN6. The predominant character species in areas EN6 and EN9 were the mud shrimp *Callianassa subterranea*, the polychaet *Nephtys hombergii*, the brittle star *Amphiura filiformis* and the phoronida. Overall, these areas had the lowest mean abundance and species numbers 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 Area EN6. The bivalve mollusc *Spisula elliptica*, which is considered critically endangered (Red List category 2), as well as the bivalve molluscs *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 seapen and burrowing megafauna communities have been identified. The unthreatened species *Callianassa subterranea* was found relatively frequently, and the species classified with an indeterminate threat, *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 Area EN6 is considered to be of average to above-average importance because of the occurrence and ecological importance of burrowing bottom megafauna.

Based on the data collected in 2008–2009, the benthic community in area EN9 can be assigned to the *Amphiura filiformis* association. Within the EN9 area, between 128 and 130 macrozoobenthos taxa were detected (PGU 2012a, b; PGU 2015). Despite a relatively large temporal variability in the species composition, the same species, *Nucula nitidosa, Corbula gibba, Nephtys hombergii,* and *Amphiura filiformis,* dominated the benthic community as in the EN6 area. In addition, the dominant species were the horseshoe worm *Phoronis* spp., the mud shrimp *Callianassa subterranea* and polychaetes of the genus Nephtys. In terms of biomass, Area EN9 was also dominated in particular by the heart sea urchin *Echinocardum cordatum* and the tower snail *Turitella communis*.

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 bottom mega-fauna. *Upogebia stellata* is considered critically endangered (Red List category 2) and the *Arctica islandica* is considered endangered (Red List category 3).

Due to the occurrence of species of seapen and burrowing megafauna communities, the benthic community in the EN9 area 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 (Nordwestliche Deutsche Bucht I) was identified by DANNHEIM et al. (2014a). These offshore areas are mainly characterised by the bivalve mollusc *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 investigations were mainly the brittle star *Amphiura filfiformis*, the bivalve molluscs *Mysella bidentata*, *Nucula nitidosa*, *Abra alba,* and the Polychaet *Scalibregma inflatum*.

The overall biodiversity and number of Red List species can be described as average for the areas mentioned. Due to the ecological importance of the seapen and burrowing megafauna communities identified in the studies of the areas, benthos is of average to above-average importance overall in these areas.

With regard to the description of the benthic biocoeneses in the EN7 area, results of the benthic surveys from 2002 to 2010 can be used for this. Area EN7 is essentiall 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 widely distributed and not endangered in the North Sea EEZ.

The diversity of the infauna in the southern part of the EN7 area comprised 122 taxa, with the polychaeta being the most species-rich, followed by the crustacea and mollusca. The most dominant species was the nutmeg *Nucula nitidosa*. Other dominant species were the Polychaeta *Nepthys hombergii* and the bivalve mollusc *Corbula gibba*. The biomass was determined by the heart urchin *Echinocardium cordatum* and auger shell *Turritella communis.* Of the two species of seapen and burrowing megafauna communities, *Callianassa subterranea* was found relatively frequently, while *Upogebia deltaura was* found in relatively small numbers.

Due to the occurrence of seapen and burrowing megafauna communities, the benthic community in the EN7 area is assigned an average to above average importance. The species diversity and number of Red List species in this area can be regarded as average.

The benthos in the area of EN8 and therefore also in the area of N-8.4 can be assigned to the *Amphiura filiformis* community, but also shows elements of the *Nucula nitidosa* community. Between 146 and 169 taxa of the benthic infauna and 22 to 38 taxa of the benthic epifauna were recorded in the area of Area EN8(IFAÖ 2016, BIOCONSULT 2018). Dominant species with regard to abundance were above all the brittle star *Amphiura filiformis*, the bivalve molluscs *Nucula nitidosa* and *Corbula gibba,* and the horseshoe worm *Phoronis* spp. The biomass was dominated by the heart urchin *Echinocardium cordatum* and the auger shell *Turritella communis.*

So far, 23 to 31 species of infauna and between 16 and 23 species of epifauna, which are considered threatened or rare in accordance with Red List according RACHOR et al. (2013), have been recorded in Area EN8. The bivalve molluscs *Ensis ensis* and *Mya truncata*, the whelk *Buccinum undatum*, the Polychaet *Sabellaria spinulosa,* and the mud shrimp *Upogebia stellata* have been identified as critically endangered (Red List category 2) in isolated cases. In addition, the endangered (Red List category 3) *Arctica islandica*, the Polychaet *Sigalion mathildae* and the sea anemone *Sagartiogeton undatus were* also found in low abundance in the EN8 area. *Callianassa subterranea*, *Upogebia deltaura*, *U. stellata* and *Nephrops norvegicus,* four species of seapen and burrowing megafauna communities have been identified, but only the species *Callianassa subterranea, which is considered* harmless, has been found in higher abundances.

Due to the average species diversity, an above-average number or abundance of Red List species, and the occurrence of several species of seapen and burrowing megafauna communities, the importance of benthos in the EN8 area can be rated as average to above average.

Reservation areas for wind energy EN14 to EN18

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

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

Reservation 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 shows a higher diversity and equivalence compared to the coastal regions due to more balanced dominance ratios. However, there are lower abundances and biomasses far from the coast compared with the more productive coastal 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 EN19, a change in the composition of the benthic fauna takes place. This boundary corresponds to the boundary between intermixed and stratified water masses and the associated strong changes in the biotic and abiotic environment; this results 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 m² compared with the other communities of the EEZ of the North Sea.

All in all, benthos is therefore of above-average importance in this area. While the community of the central North Sea is limited to the EN19 area within the EEZ, it is relatively widespread outside the German EEZ.

Reservation areas for raw material extraction SKN1 and SKN2

In the reservation areas SKN1 and SKN2 for sand and gravel extraction in the area of the nature conservation area "Sylter Außenriff – Östliche Deutsche Bucht", areas of species-rich gravel, coarse sand, and shingle grounds 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 benthos are of above-average importance.

2.7 Fish

As the most species-rich of all vertebrate groups living today, fish are equally important in marine ecosystems as predators and prey. Bottom-dwelling fish feed mainly on invertebrates living in and on the seabed, while pelagic fish species eat almost exclusively 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 for seabirds and marine mammals.

For a first subdivision of the fish fauna, the way of life of the adult animals lends itself. Bottom-living (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, while pelagic fish stay temporarily near the bottom. At almost 60%, demersal fish are the most common in the North Sea, ahead of pelagic (20%) and benthopelagic (15%) species. Only about 5% cannot be assigned to any of the three lifestyles because of a close habitat connection (FROESE & PAULY 2000). The individual life stages of each species often differ more in form and behaviour than the same stages of different species: Pelagic herring lay their eggs in thick mats on sandy-gravelly bottoms or glue* them to suitable substrate such as algae or stones (DICKEY-COLLAS et al. 2015); all flatfish have pelagic larvae that transition to bottom life when they metamorphose into their characteristic body shape (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 – from egg to mature adult – there and are therefore described as *permanent residents** (LOZAN 1990). They include commercially fished species (e.g. sand eel, mackerel, and sole) as well as economically insignificant species (e.g. 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 barb. However, very small juveniles* of these two species have been recorded recently, thus suggesting reproduction in the area (HEESSEN 2015, DÄNHARDT 2017).

Some species occur irregularly in the North Sea regardless of the season; these include sculpin, bream, dogtooth, and halibut. Of these and other so-called "misguided" species, only single specimens are usually caught.

Unlike the marine fish in the three categories mentioned above, the life cycle of the diadromous species spans sea and freshwater. As the only 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, twaite shad, and sea lamprey are examples of this.

The most important influences on fish populations are fishing 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 day-length-controlled phytoplankton development. Because of this “mismatch”(CUSHING 1990, BEAUGRAND et al. 2003), fish larvae may find a reduced density of zooplankton when they rely 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 the predators at the top of the food web (DURANT et al. 2007, DÄNHARDT & BECKER 2011) and has implications for the managent of fish stocks.

Impacts of fishing and climate change interact and can hardly be distinguished in their relative effect on fish population dynamics (DAAN et al. 1990, VAN BEUSEKOM et al. 2018). Thus, 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 fishing into consideration (FAUCHALD 2010). Despite its complexity, a holistic view of the effects of various stressors on the fish fauna offers the possibility of identifying negative effects early on and, if necessary, initiating targeted measures.

2.7.1 Data situation

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

- 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 (from 2014) results from environmental impact studies and cluster investigations for the preparation of current species lists (only areas N-1 to N-8).
- the Database of Trawl Surveys (DATRAS) of the International Council for the Exploration of the Sea (ICES) (accessed on 12 March 2018). Only the standard areas and grid squares covering the German North Sea EEZ were considered. In standard roundfish 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) have been combined. For 2018, data from the 1st quarter were already available and were combined with the data from the 3rd quarter of 2017.

It should be taken into consideration that the supplementary DATRAS data were carried out with different fishing gear as well as deviating haul numbers and towing times compared with the investigations of the environmental impact studies and cluster investigations. For a historical reference, EHRICH et al. (2006) and KLOPPMANN et al. (2003) was considered. The classification in the North Sea-wide context was done with the help of HEESSEN et al. (2015). For the current assessment (2017/2018) of the exploited stocks, the internet portal "Fish stocks online"(BARZ & ZIMMERMANN 2018) was used; this 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 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 on different spatial and temporal scales. Hydrographic and, to a large extent, climatic factors, such as swell, tides and wind-induced currents, as well as the large-scale circulation of the North Sea, have an impact over a large area. On medium (regional) to small (local) space-time scales, water temperature and other hydrophysical and hydrochemical parameters as well as food availability, intra- and interspecific competition, and predation, which includes fishing, have an impact. Another crucial factor for the distribution of fish in time and space is habitat. In a broader sense, this 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 obstruction of migration routes of migratory species and fisheries, and to structures in the sea. Newly introduced structures can serve as spawning substrate (sheet piling for herring spawn) or food source (growth on artificial structures) for some fish species (EEA 2015). Some fish species (e.g. 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 ships), a general ban on navigation and use is regularly envisaged within the OWF sites with the consequence that no fishing takes place in the area. There is a need for research on whether the fish community uses the fishery-free area as a refuge. Further information on the impacts 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 fish and lamprey species established in the North Sea, the threat was assessed in the context of the Red List based on the current population situation as well as long-term and short-term population trends (THIEL et al. 2013). According to the Red List, 23.4% (25 species) of the established marine fish and lamprey species in the North Sea are classified as extinct or at risk of extinction. Taking extremely rare species into account, the proportion of Red List species increases to 27.1% (29 species). Five of these species (allis shad, twaite shad, houting, river lamprey, and sea lamprey) are additionally listed in Appendix 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 fish species analysed (16.9%) had a Red List endangered* status: Allis shad*, thornback ray, and spiny dogfish are threatened with extinction (Category 1), European eel, dogfish, and haddock are considered critically threatened (Category 2), while fin, starry ray, river lamprey, greater petrale, and dwarf cod are endangered (Category 3). The authors identified an endangerment of unknown extent (category G) for the snake pipefish, ling, great pipefish, and the ballan wrasse is extremely rare (category R).

2.7.2.2 Typical regional fish communities in the EEZ

KLOPPMANN et al. (2003) detected a total of 39 fish species during a one-off investigations to survey fish species of Appendix II Habitats Directive in the German EEZ in the areas of Borkum-Riffgrund, Amrum-Außengrund, Osthang Elbe-Urstromtal, and Doggerbank in May 2002. The study identified a gradual change in the species composition of the fish communities from the inshore 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 using effort-corrected catch figures: The largest formed the central community (ZG), which were demarcated in the north by the two communities of the duckbill (ES I and ES II) and along the coast by a coastal community (KG) (Figure 28 and Figure 29). Areas with less than six stations were not assigned to any fish community (grey symbols in Figure 28).

The four identified fish communities had a similar species composition in principle, but with different species-specific abundances. Dab were generally dominant and very regular, while plaice and American plaice dominated in the offshore community ES II. Plaices were also regularly found in the central transitional community. Dragonets and hooknoses were characteristic of the coastal community of demersal fish. Solenettes and dragonets were also regularly found in the central transitional community. The species composition and distribution of demersal fish showed gradual changes from the offshore community to the central community to the nearshore areas. The species number of community ES I was clearly 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).

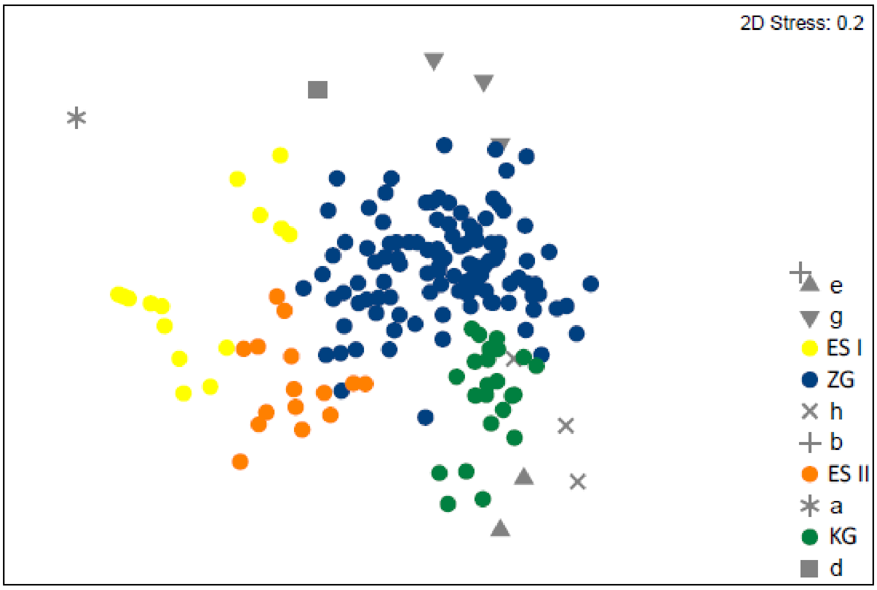


Figure 28: Relative similarity of species composition and species-specific abundances of bottom-dwelling fish in the German North Sea EEZ. The central community (ZG, blue dots), the coastal community (KG, green dots) and two Duck`s Bill communities (ES I & II, yellow and orange dots) can be clearly distinguished. Areas with fewer than six stations have not been 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).

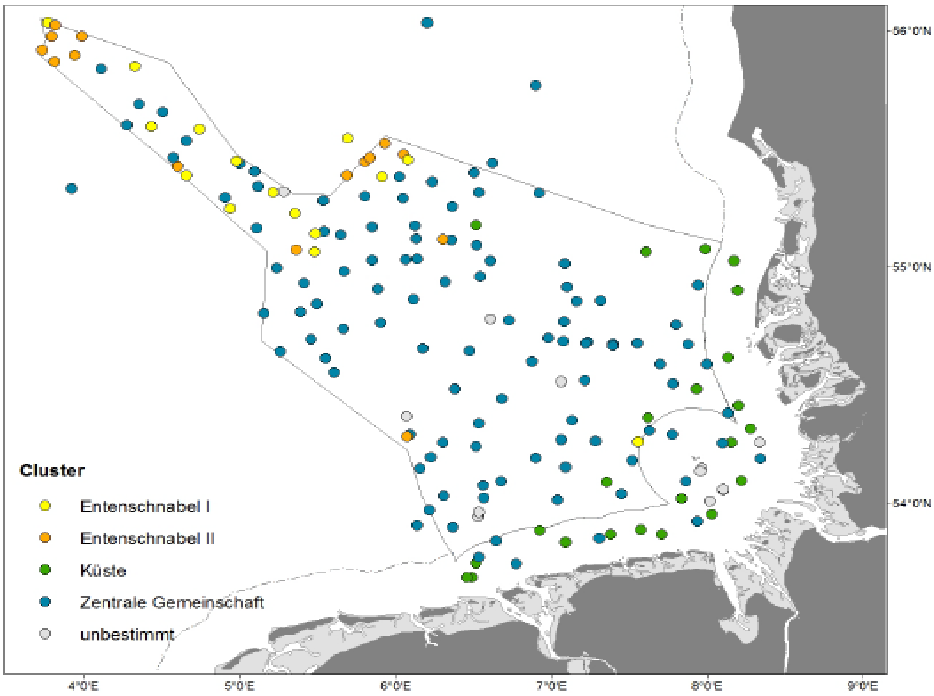


Figure 29: Map of the spatial variability of the fish communities identified in the German North Sea EEZ based on abundance data corrected for effort. Abbreviations, methods of analysis, colour coding, and sample size as in Figure 28. From DANNHEIM et al. (2014).

Like species numbers, demersal* fish abundance increased with proximity to the coast, from 4,454 ± 3,598 individuals * km^{-2} in the offshore ES I to 95,128 ± 44,582 individuals * km^{-2} in the coastal community (Figure 30a). The biomass, on the other hand, did not show a directional geographical trend, with the lowest biomass being found in ES I (108 ± 112 kg * km-2). The largest biomass was found in ES II with 801 ± 513 kg * km^{-2} (Figure 30b).

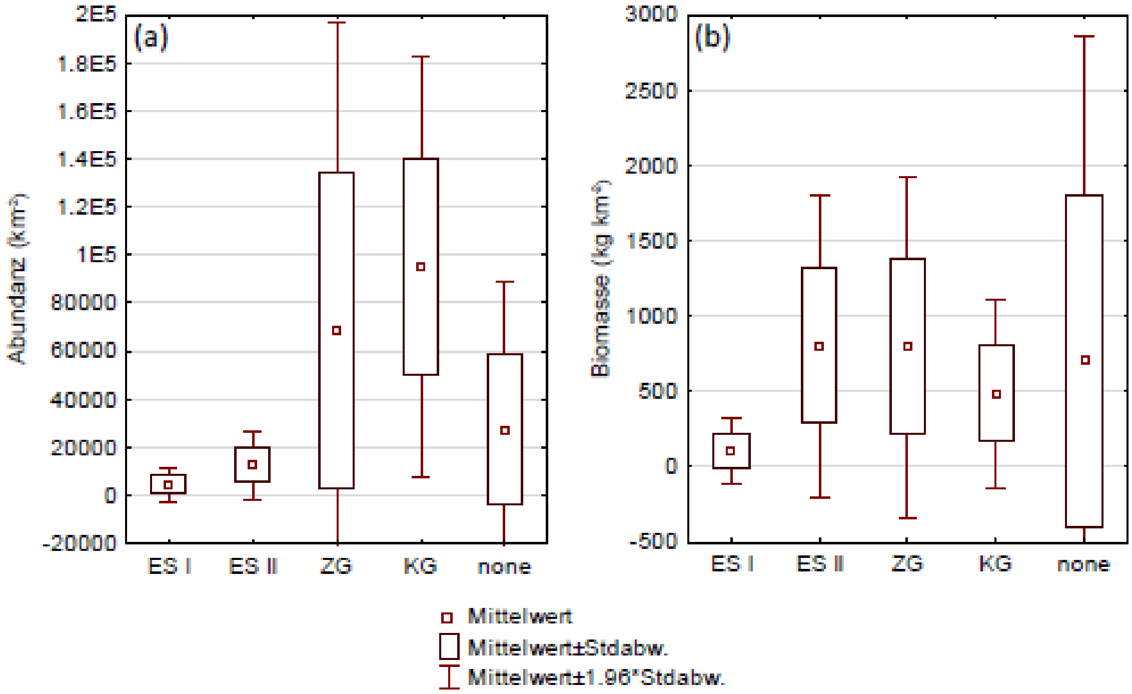


Figure 30: Box whisker plots of (a) abundance (individuals * km-2) and (b) biomass (kg * km-2) of the identified fish communities in the German North Sea EEZ. Abbreviations, analytical methods, and sample sizes as in Figure 28. From DANNHEIM et al. (2014).

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 Spatial Offshore Grid Plan (BSH 2017). The classification of the areas corresponds to the designations for offshore wind energy in the spatial plan. In the following, these wind farm areas are therefore referred to as OWF Areas EN1-EN12 (Figure 31 below). In order to exclude temporal effects on the spatial analyses, data from all OWF areas were analysed in pairs separately by year and season (Figure 31 top left). The individual OWF areas were compared in pairs by means of single factor similarity analyses (ANOSIM), whereby the mean R-value was 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 indicate 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, and R-values close to 1.00 indicate complete separation of groups (CLARKE & GORLEY 2001). Without the influence of temporal effects, the western OWF areas EN1 and EN2 (SW-W DB) were separated from the eastern OWF area EN3 (SW-O DB) in the Südwestlichen Deutsche Bucht off the East Frisian coast (Figure 31). Furthermore, the analyses showed a separation of the coastal OWF areas EN4 (S EUT) and EN5 (N EUT) along the edge of the Elbe River valley. The greatest similarity (indicated by low R-values) in terms of species-specific fish abundance was between OWF areas EN6 to EN12 in the Nordwestliche Deutsche Bucht (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 31) stood out clearly; the degree of dissimilarity sometimes varied greatly even between neighbouring geo-clusters. While OWF areas EN5 and EN6 were very similar (mean R-value = 0.42), the fish community of OWF area EN12 differed significantly from that of OWF area EN10 within the NW DB geocluster (R = 0.84) (Figure 31 top left). The separation of the geo-clusters on the basis of species-specific abundance should therefore be understood as a spatial gradient in the community characteristics rather than a sharp demarcation of different demersal fish communities. The number of demersal fish species is generally very similar between the geo-clusters: In the SW-W DB geo-cluster, 13 ± 3 species per haul were caught on average, while the fewest fish species (11 ± 3) were found in the N EUT geo-cluster. Furthermore, the geo-clusters did not show any geographically clear differences in the 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: More than 60% of the species were found across different areas. Only five species were relevant for the dissimilarity between the geo-clusters. Dwarf tongue, dab and plaice were found in all geo-clusters, but they contributed to the similarity to a varying degree. Scaldfish were characteristic of the western geo-clusters (SW-W DB, SW-O DB, NW DB), while gobies were characteristic of the geo-clusters along the Elbe Glacial Valley and eastern areas (N EUT, S EUT). Structural differences in species composition are hardly present between the geo-clusters. Differences are based solely on the different abundances of species.

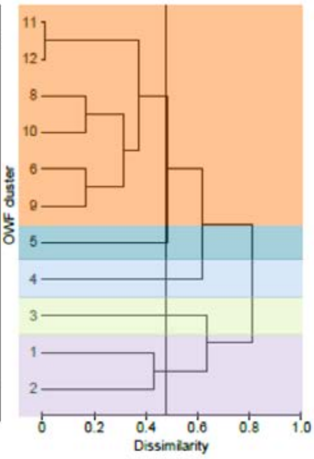
2.7.3 Status assessment of the protected asset fish

The status assessment of the demersal fish community of the EEZ of the German North Sea is based on i) rarity and threat, ii) diversity and distinctiveness, and iii) legacy impact. These three criteria are defined below and applied separately for Areas EN1-EN3, for Area EN4, for Area EN5, for Areas EN6–EN8, and for Areas EN9-EN13.

Rarity and threat

The rarity and threat of the fish community is assessed on the basis of the proportion of species that are considered threatened 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 lost (0), Critically endangered (1), Severely threatened (2), Threatened (3), Threat of unknown extent (G), Extremely rare (R), Pre-warning list (V), Data insufficient (D) or Non-threatened (*) (THIEL et al. 2013). Special attention is paid to the endangerment situation of species listed in Appendix II of the Habitats Directive. They are the focus of Europe-wide conservation efforts and require special protective 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											



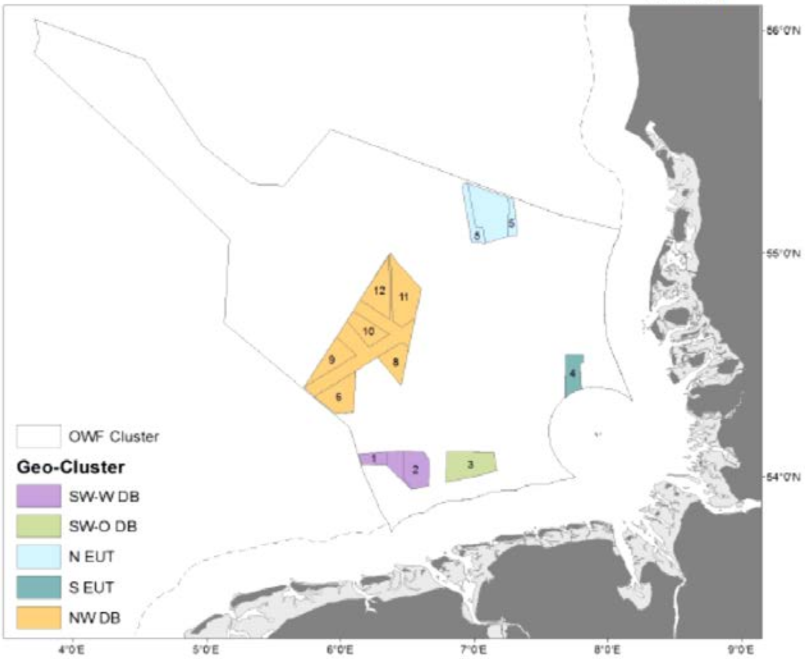


Figure 31: Above: R-values for the diversity of OWF areas (single factor ANOSIM) based on abundance data of demersal fish. The R-values correspond to the mean R-value of the individual pairwise tests between the OWF areas. Above: Differences between the identified geo-clusters in different colours. Below: Map of the OWF areas (numbers) and location of the geo-clusters determined from the R-values (single factor ANOSIM) (colours, see map legend). SW-W DB: western Südwestliche Deutsche Bucht, SW-O: eastern Südwestliche Deutsche Bucht, N EUT: Northern Elbe River Valley, S EUT: Southern Elbe River Valley, NW DB: Nordwestliche Deutsche Bucht. From DANNHEIM et al. (2014).

During the environmental impact assessments and the fish monitoring for stock assessment in the aforementioned period, a total of 37 fish species have been identified in the lake areas where areas **EN1, EN2, and EN3** are located (Chapter 2.7.1). Of these, according to THIEL et al. (2013), no species is considered extinct or lost (0); the thornback ray (1 species, 2.7%) is threatened with extinction (1), and no critically threatened species (2) have been recorded. The greater weever is considered threatened (3) (1 species, 2.7 %). For the common pipefish and the ocean pipefish, an indeterminate threat (G) is assumed (2 species, 5.4%). None of the species detected in Areas EN1–EN3 is extremely rare (R), while mackerel, turbot, and sole are classified near-threatened (3 species, 8.1%). For the lesser sandeel*, the ornamental eggfish, the large spotted sandeel, the spotted goby and the sea bull (five 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 non-threatened (*); these include the three-spined stickleback, 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; none of these are considered extinct or lost (0), threatened with extinction, or severely threatened (2) according to THIEL et al. (2013). One species, the starry ray, is considered threatened (3) (1 species, 2.7%). The threat of the ocean pipefish is unknown (G) (1 species, 2.7%), while smelt (assessed in FREYHOF 2009), mackerel, turbot, and sole are classified as near-threatened (4 species, 10.8%). For another three species (8.1%), the lesser sandeel, the ornamental eggfish, and the greater spotted sandeel, the available data are insufficient for an assessment (D). 28 species (75.7%) are considered to be unthreatened (*) (Table 9).

In the lake area where **Area EN5** is located, a total of 35 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), critically endangered (1), endangered (2), or extremely rare (R). Likewise, none of the species found in Area EN5 is there an indeterminate threat (G). FREYHOF (2009) estimates the river lamprey as endangered (3) (2.9%); just as in the areas already discussed, mackerel, turbot, and sole are classified as near-threatened (3 species, 8.6%). Data for the lesser sandeel, tobias, ornamental eggfish, and greater spotted sandeel are considered insufficient, and 27 species (77.1%) are considered unthreatened (*) (Table 9).

In the lake areas where **Areas EN6-EN8** are located, a total of 39 species were detected 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), while the thornback ray (1 species, 2.6%) is critically endangered (1). The European eel and the dogfish (2 species, 5.1%) are severely threatened (2), the starry ray and the common thresher are classified as threatened (3) (2 species, 5.1%), while the common pipefish is considered to be at threat of unknown magnitude (G). (G) (1 species, 2.6%). The spotted ray (1 species, 2.6%) is extremely rare (R); mackerel, turbot, and sole are classified as near-threatened (V) (3 species, 7.7%). For the lesser sandeel and the greater spotted sandeel, the data available are insufficient for an assessment (D) (2 species, 5.1%), 27 species (69.2%) are considered unthreatened (*) (Table 9).

In the sea areas where **Areas EN9-EN13** are located, no environmental impact assessments have taken place so far. The assessment is therefore based solely on fish monitoring data for stock assessment, and therefore on a smaller number of hauls, which may affect species numbers. A total of 29 species were recorded in Areas EN9-EN13; none of these are considered extinct or lost (0), severely threatened (2), extremely rare (R) or at a threat of unknown magnitude (G) according to THIEL et al. (2013). The spiny dogfish is critically endangered (1) (1 species, 3.4%), and the starry ray is considered vulnerable (3) (1 species, 3.4%). As in all other clusters considered, mackerel, turbot, and sole are also classified as near-threatened (3 species, 10.3%). For the lesser sandeel, the greater spotted sandeel, and the hake, the data available are insufficient for an assessment (D) (3 species, 13.8%). 20 species (69%) are considered to be unthreatened (*) (Table 9).

Table 9: Relative proportion of Red List categories in fish species detected in Areas EN 1–3, 4, 5, 6–8, and 9–13. Extinct or lost (0), Critically endangered (1), Severely threatened (2), Threatened (3), Threat of unknown extent (G), Extremely rare (R), Pre-warning list (V), Data insufficient (D) or Non-threatened (*) (THIEL et al. 2013). (EIA data from 2014 for clusters 1-8 and data from 2017/2018 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 EN	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 fish, 27.1% of the species assessed were assigned to a risk category (0, 1, 2, 3, G or R), 6.5% are on the early warning list and for 22.4% no assessment is possible due to lack of data. A total of 43.9% of the species are considered to be unthreatened (THIEL et al. 2013) (Table 9). In comparison, significantly fewer species with a threatened status were detected 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 many more unthreatened 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%).

No extinct or missing species (category 0) were 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 species in category G (threat 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 in categories V (early warning list) and * (not endangered) were found in all areas, which means that they have above-average importance for species in these two categories. The proportion of species that could not be assessed because of lack of data (D) was clearly below the proportion of this category in the Red List (Table 9) in all areas. Two species protected under the Habitats Directive and the Protected Area Ordinance for “Sylter Außenriff – Östliche Deutsche Bucht” were found in the form of the twaite shad (Areas EN6-EN8) and the river lamprey (Area EN5), albeit as single catches; from this, the importance of these areas for the species cannot be deduced.

Against this background, the rariteness and vulnerability of the fish fauna in the areas under consideration is rated as average to above average.

Diversity and uniqueness

The diversity of a fish community can be described by the number of species (α-Diversity, “species richness”). The species composition can be used to assess the specific nature of a fish community, i.e. how regularly habitat-typical species occur. The following section compares and assesses the diversity and individual characteristics of the entire North Sea and the German EEZ, and of the EEZ and the individual areas.

Over 200 species of fish have been recorded in the North Sea so far (DAAN 1990: 224, LOZAN 1990: >200, FRICKE et al. 1994, 1995, 1996: 216, Froese & Pauly 2000: 209). The vast majority of these are rare individual records. Less than half of them reproduce regularly in the German EEZ or are found as larvae, young or adult specimens. According to these criteria, only 107 species are considered established in the North Sea (THIEL et al. 2013). The International Bottom Trawl Survey (IBTS) has identified 99 fish species in the entire North Sea between 2014 and 2018. In the German EEZ, represented here by area-related fish data from environmental impact studies (from 2014) and the ICES DATRAS database (IBTS data 2017 & 2018), a total of 56 species were identified. With the exception of Areas EN9–EN13, the number of species in the individual sites was close together between 35 and 39 (cf “Rarity and threat”). Most species were found in Areas EN6-EN8 followed by Area EN4, EN1–EN3, and EN5. In Areas EN9–EN13 in Zone 3, only 29 species were recorded (Table 10); this could be at least partly due to the lower recording effort in this area.

All typical demersal flat and round fish species have been identified across the area. The steady and characteristic flatfish species* lambezi, lemon sole, dab, lemon sole, plaice, turbot, brill, and sole were present in all areas considered. Flounder were caught in four out of five areas despite their coastal and estuarine affinity (Table 10).

Although the bottom trawls used are unsuitable for recording pelagic fish, the species typical of the pelagic part of the fish community, namely herring, mackerel, and sprat were recorded in all areas (Table 10).

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

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

Of the 56 species found in the German EEZ during the period under consideration, only 19 species occurred in all areas; 10 species were found in four areas, five species were found in three areas, and six species only in two areas (Table 10). The remaining 16 species were caught in only one area each, whereby the anadromous species (e.g. the twaite shad, river lamprey, or smelt), species with an affinity to the coast (e.g. three-spined stickleback, flounder, or gobies) of the genus *Pomatoschistus*, or species dependent on coastal habitats (seagrass meadows) such as the lesser pipefish occurred, as expected, in the coastal clusters. In the offshore areas (Areas EN9-EN13), these species were absent. In contrast, hake and dogfish 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. Also in all areas, the typical and characteristic species of both the pelagic and demersal components of the fish communities under consideration were represented. The overall diversity and characteristics can be considered as average in all areas.

Legacy impacts

The southern North Sea has been intensively used for centuries. Fisheries are probably the most damaging to the natural habitat and the fish community. Nutrient pollution can also affect the natural habitat. In addition, fish are subject to other direct or indirect human influences such as shipping traffic, pollutants, sand and gravel extraction. However, these indirect influences and their effects on the fish fauna are difficult to prove. In principle, it is not possible to reliably separate the relative effects of individual anthropogenic factors on the fish community and their interactions with natural biotic (predators, prey, competitors, reproduction) and abiotic (hydrography, meteorology, sediment dynamics) parameters of the German EEZ. However, due to the removal of target species and by-catch and the impact on the seabed in the case of bottom fishing methods, fishing is considered to be the most effective source of pollution for the fish community. There is no assessment of stocks on a smaller spatial scale such as the German Bight. Consequently, the assessment of this criterion cannot be carried out at area level, but only for the whole North Sea.

Of the 107 species considered established in the North Sea, 21 are fished commercially (THIEL et al. 2013). The assessment of the impact of fishing 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 taking of target species and by-catch species. The latter often include protected, endangered or threatened species, including not only fish but also birds and mammals (ICES 2018b). Some 6600 fishing vessels from 9 nations fish in the North Sea. The largest quantities were landed in the early 1970s and catches have been declining since then. However, a reduction in fishing effort has only been observed since 2003.

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

Commercial fishing and spawning stock sizes are assessed against maximum sustainable yield (MSY), taking into consideration the precautionary approach. A total of 119 stocks throughout the North Sea were considered in terms of fishing intensity; of these, 43 are the subject of a scientific stock assessment (Figure 32). Of the 43 stocks assessed, 25 are managed sustainably. 38 of the 119 stocks were assessed for their reproductive capacity (spawning biomass); 29 stocks are able to use their full reproductive capacity (Figure 32).

The biomass proportion of the total catch (5,350,000 t in 2017) managed at too high a fishing intensity outweighs the proportions of sustainably caught and unassessed fish stocks in the North Sea (Figure 32). Fish from stocks for which the reproductive capacity is above the reference level account for the majority of biomass in the catch (3,709,000 t, Figure 32).

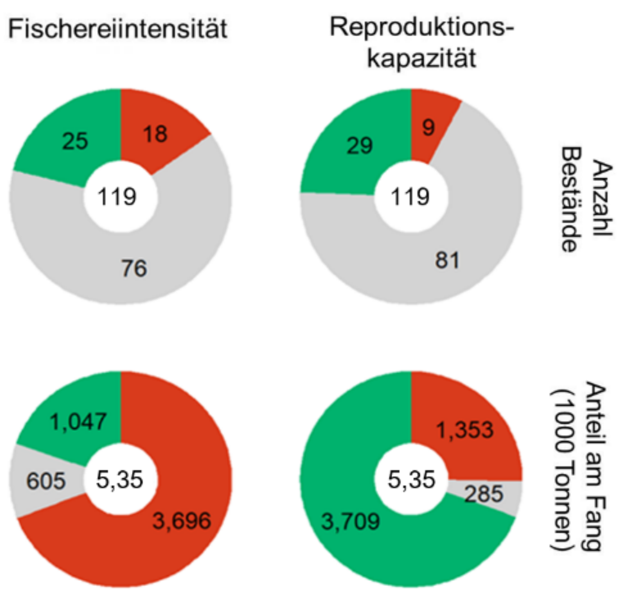


Figure 32: Summary of the status of fish stocks throughout the North Sea in 2017, focusing on fishing intensity and reproductive capacity. Left: Fishing intensity indicates the number of stocks (top) and the biomass share of the catch (bottom; in 1,000 tonnes) that is below (green) or above (red) the reference level (fishing intensity for sustainable yield, FMSY). Right: Reproductive capacity indicates the number of stocks (top) and the biomass share of the catch (bottom) that is above (green) or below (red) the reference level (spawning biomass, MSY Btrigger). Grey indicates the number or biomass share of the catch of stocks for which no reference points have been defined and for which no stock assessment is therefore possible. Consideration of a total of 119 stocks. Amended according to ICES 2018a.

Overall, fishing mortality of demersal and pelagic fish has decreased significantly since the late 1990s. 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 measures (e.g. for cod, whiting, or mackerel). Moreover, for the vast majority of the stocks exploited, no reference levels are defined, which makes it impossible to carry out scientific stock assessments.

Alongside fisheries, 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 carried in via rivers; this leads to a pronounced gradient in nutrient concentration from the coast to the open sea (BROCKMANN et al. 2017). Major direct effects of eutrophication are increased chlorophyll-a concentrations, reduced visibility depths, local decline in seagrass areas and vegetation density with associated mass reproduction of green algae. Above all, the seagrass meadows of the Wadden Sea perform an important protective function for the fish spawn and provide a protection and feeding area for numerous young fish between the stalks. With the increasing decline of the seagrass beds due to eutrophication, there are fewer retreat areas and potentially higher predation rates. The indirect effects of nutrient enrichment, such as oxygen deficiency and a changed species composition of macrozoobenthos, may also have an impact on the fish fauna. In many species, the survival and development of fish eggs and larvae depends on oxygen concentration (SERIGSTAD 1987). Depending on how much oxygen is needed, lack of oxygen can lead to the death of the fish spawn and larvae. In addition, the altered species composition of benthic organisms can also affect the biodiversity of the fish community, especially that of food specialists.

Due to the fact that, according to ICES, the abundance of fish species in the North Sea has not decreased for 40 years (number of species per 300 hauls; catch data from the International Bottom Trawl Survey, IBTS), and that the commercially exploited stocks are also subject to strong natural fluctuations, the biota of the fish fauna in the German EEZ was assessed as average. This assessment is supported by the summary of fishing metrics and the ecosystem effects of bottom-disturbing fishing (WATLING & NORSE 1998, HIDDINK et al. 2006).

2.7.3.1 Importance of the areas for fish

The overall criterion for the importance of the areas for fish is the relation 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 did not show any particular importance of a special area (Table 10) for the constant, frequent character species. However, there is a tendency for areas closer to the coast to be home to more species. Although this could be an artefact of the different numbers of wood, an overlap between the habitat of inshore fish species and existing and future wind farm sites is quite plausible in view of the mobile lifestyle and life cycle of most species. The higher proportion of species with an affinity for the coast in the areas close to the coast could therefore be an indication that areas EN1 to EN3, area EN4 and area EN5 are more important for fish with an affinity for the coast, such as butterfish, smelt and pipefish, than the areas farther away from the coast. These areas also lie along the migratory route of herring spawning along the east coast of the UK in autumn and winter. The larvae first reach the near-coastal nursery areas with the counterclockwise residual current of the North Sea (DICKEY-COLLAS et al. 2009), from where they recruit as one- or two-year-old fish, also along the coast, to the adult population.

Plaice spawning in the central North Sea migrate to their nursery areas along the coast (BOLLE et al. 2009), crossing all the areas under consideration here, which may thus be significant as transit areas for one of the most common fish species in the North Sea. The fact that spiny dogfish have only been caught in areas EN9 to EN13 may not yet be sufficient to establish a special importance of these areas for this species, as spiny dogfish are also found along the coast. In areas EN6 to EN8, slightly higher percentages of endangered, critically endangered, vulnerable and endangered species were found than in other areas, which were also above the Red List average. For these species, this area could be of greater 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 seals (*Phoca vitulina*). All three species are characterised by high mobility. Migrations (especially in search of food) are not limited to the EEZ, but also include the territorial 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 territorial waters. To search for food, they undertake extensive migrations in the open sea from their moorings. Due to the high mobility of the 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 are also observed in the German North Sea EEZ, such as white-sided dolphins (*Lagenorhynchus acutus*), white-beaked dolphins (*Lagenorhynchus albirostris*), bottlenose dolphins (*Tursiops truncatus*) and minke whales (*Balaenoptera acutorostrata*).

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

2.8.1 Data situation

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

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

The German waters currently belong to the areas of the North Sea which have been systematically and very intensively investigated for the presence of marine mammals since 2000. The bulk of the data is provided by the investigations carried out as part of environmental impact studies and site investigations to determine the suitability of sites as well as construction and operational monitoring for offshore wind farms. In addition, studies for monitoring nature conservation areas are regularly carried out on behalf of BfN. Finally, data are also collected within the framework of research projects that investigate specific issues.

Data availability can currently be described as very good for the areas EN1 to EN13 in the German EEZ. 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:

- the whole North Sea and adjacent waters: Studies carried out under SCANS I, II and III in 1994, 2005 and 2016,
- Research projects in the German EEZ and in the territorial waters (including MINOS, MINOSplus (2002–2006), and StUKplus (2008–2012)),
- Investigations into compliance with the requirements of the UVPG within the scope of licensing and planning approval procedures of the BSH and from the construction and operational monitoring of offshore wind farms since 2001 and continuously,
- Monitoring of the nature conservation areas on behalf of the BfN since 2008 and continuously.

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

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

Information on the occurrence of marine mammals is also provided by observations within the framework of the ship-based recording of resting and seabirds according to StUK.

Current findings are obtained from the monitoring of offshore projects in priority areas EN1, N2 and EN3 (investigation cluster North of Borkum), in priority area EN4 (investigation cluster North of Helgoland), as well as from individual projects in 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 investigations for offshore wind farms and the investigation of nature conservation areas. Data availability for the priority areas EN14 to EN19 consists exclusively of the results of research projects and individual surveys for the "Dogger Bank" nature conservation area.

The large-scale distribution and abundance in the German EEZ is surveyed as part of the monitoring of Natura 2000 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 course of the seasons. In order to be able to draw conclusions about seasonal distribution patterns and the use of areas as well as the effects of seasonal and interannual variability, large-scale long-term studies are particularly necessary.

2.8.2.1 Harbour porpoise

The harbour porpoise (*Phocoena phocoena*) is the most common and widespread whale 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 harbour porpoises is restricted to continental shelf seas with water depths predominantly between 20 m and 200 m because of their hunting and diving behaviour (Read 1999, Evans, 2020). The animals are extremely mobile and can cover long distances in a short time. Satellite telemetry has shown that harbour porpoises can travel up to 58 km in one day. The marked animals have behaved very individually in their migration. Between the individually chosen places of stay*, there were migrations of a few hours to a few days (Read & Westgate 1997).

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

The best overview of the occurrence of harbour porpoises 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 make it possible to estimate stock size and population trends in the entire area of the North Sea, which is part of the habitat of highly mobile animals, without the need for detailed mapping of marine mammals in sub-areas (seasonal, regional, small-scale). The abundance of harbour porpoises in the North Sea in 1994 was estimated at 341,366 animals based on the SCANS-I survey. In 2005, a larger area was covered by the SCANS II survey and, as a result, a larger number of 385,617 animals was estimated. However, the abundance calculated on an area of the same size as in 1994 was approximately 335,000 animals. The latest 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. Results from SCANS I, II, and III indicate no 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 southwest than in the northwest in 2005 (LIFE04NAT/GB/000245, Final Report, 2006) and in 2016 high abundances were recorded throughout the English Channel. The results of 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 (CV = 0.18) individuals; this is comparable to the abundance in 355 in 2005, and 289 in 1994 (CV = 0.14) (Hammond et al. 2017).

The abundance calculated in SCANS I, II, and III is also comparable to the statistical value of 361 (CV 0.20) from modelling data from study conducted from 2005 to 2013 (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 the UK, Belgium, the Netherlands, Germany and Denmark for the years 2005 to 2013 inclusive were considered together in the study. Data from large-scale and transboundary visual surveys such as those collected in the SCANS-II and Doggerbank 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 in the course of 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 sandeels. The food availability was modelled by the distance of the animals to known sandeel habitats in the North Sea. The habitat modelling showed significantly high densities in the area west of

Dogger Bank, especially in 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).

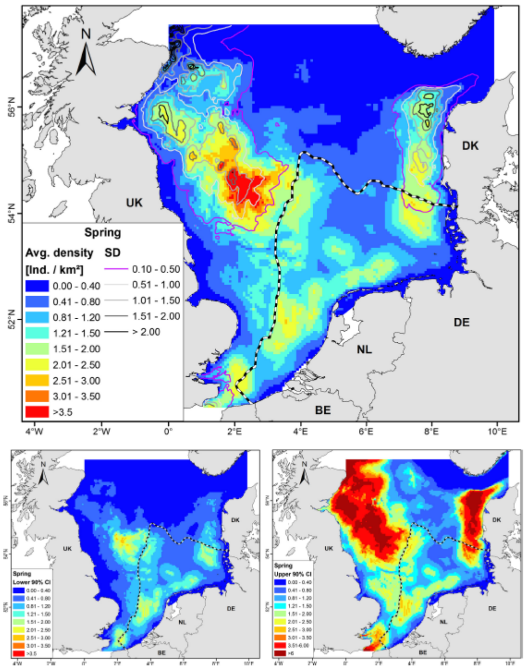


Figure 35. Occurrence of harbour porpoise in the North Sea in spring (March to the end of May): The figure above shows the averaged modelled density. The two figures below show the confidence intervals (Gilles et al., 2016).

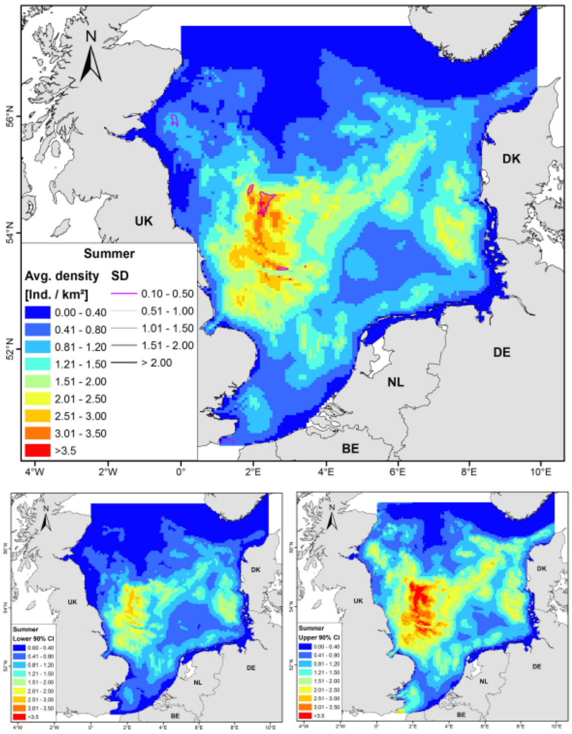


Figure 36. Occurrence of the harbour porpoise in the North Sea in the summer months (June to the end of August): The figure above shows the averaged modelled density. The two figures below show the confidence intervals (Gilles et al., 2016).

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

Occurrence of the harbour porpoise in the German North Sea

The German EEZ belongs to the North Sea harbour porpoise habitat. The north-eastern area 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 during the summer months (SONNTAG et al, 1999).

The large-scale investigations on the distribution and abundance of harbour porpoises and other marine mammals carried out 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 the German waters of the North Sea. Based on the results of the MINOS surveys (SCHEIDAT et al. 2004), the abundance of harbour porpoises in German 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 observed. The seasonal analysis of the data has shown that temporarily (e.g. in May/June 2006), up to 51,551 animals 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 Natura 2000 sites. Although the abundance varies from year to year, it remains at high levels, especially in the summer and spring months. In May 2012, the highest abundance recorded to date in the German North Sea was 68,739 animals.

The recording of harbour porpoises from 2013 onwards will cause fluctuations in the population in the EEZ with a high incidence in the nature conservation areas. In particular, the occurrence in the "Borkum Reef Ground" nature conservation area has been confirmed. The occurrence of harbour porpoises in the German North Sea EEZ can be categorised on the basis of habitat modelling of data from 2006 to 2013 inclusive on the continuous habitat of harbour porpoises in the North Sea (Gilles et al., 2016).

The distribution of harbour porpoises in the German North Sea EEZ based on current data for the years 2012 to 2018 inclusive from monitoring of the nature conservation areas and from research projects also confirms known patterns with higher occurrences in the nature conservation areas and in the harbour porpoise reserve and a rather low occurrence in the areas east/southeast of the "Sylt Outer Reef - Eastern Bight" nature conservation area and north/northwest of the "Borkum Riff Ground" nature conservation area (Fig. 37 from Gilles et al., 2019).

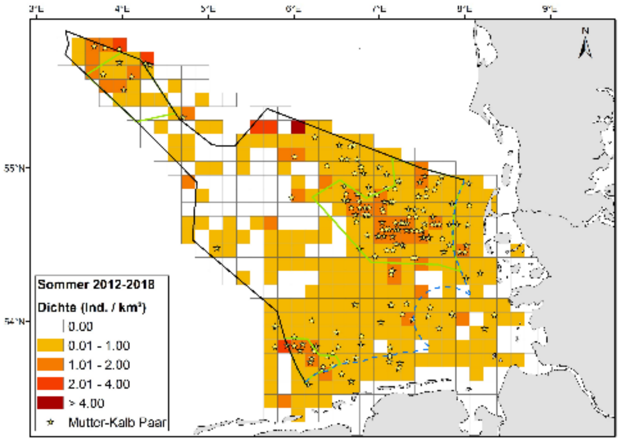


Figure 37. Occurrence of harbour porpoise in the German EEZ of the North Sea based on data from the monitoring of nature conservation areas and research projects from 2012 to 2018 inclusive (Gilles et al., 2019).

Occurrence in nature conservation areas

Based on the results of the MINOS and EMSON[9] investigations, three areas that are of particular importance for harbour porpoises were defined in the German EEZ. These were notified to the EU as offshore protected areas in accordance with the Habitats Directive and recognised by the EU as Sites of Community Importance (SCI) in November 2007: Doggerbank (DE 1003-301), Borkum Riffgrund (DE 2104-301), and especially Sylter Außenriff (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:

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

- Ordinance on the Establishment of the Nature Conservation Area "Borkum Riffgrund" (NSGBRgV), Federal Law Gazette I, I p. 3395 dated 22 September 2017,
- Ordinance on the Establishment of the "Doggerbank" Nature Conservation Area (NSGDgbV), Federal Law Gazette I, I p. 3400 dated 22 September 2017,
- Ordinance on the Establishment of the Nature Conservation Area "Sylter Außenriff – Östliche Deutsche Bucht" (NSGSylV), Federal Law Gazette I, I p. 3423 dated 22 September 2017.

The BfN has published an up-to-date description of the occurrence of harbour porpoises in the nature conservation areas, taking into account current knowledge (BfN, 2017).

The "Sylt Outer Reef - Eastern German Bight" nature conservation area is the main distribution area for harbour porpoises in the EEZ. The highest densities are often found here in the summer months. The nature conservation area "Sylter Außenriff – Östliche Deutsche Bucht" has the function of a nursery area*. In the period from 1 May until the end of August, mother-calf pairs are frequently recorded in the area of the "Sylt Outer Reef - Eastern German Bight" nature reserve.

The "Borkum Riffgrund" nature conservation area is of great importance for harbour porpoises in spring and partially in the early summer months. Significant densities are regularly recorded during this period.

The Doggerbank nature conservation area has a lower occurrence than the other two nature conservation areas. In the Doggerbank area, animals have mainly been recorded during the summer months. Mother-calf pairs also occur here. Their presence in the summer months also suggests a function as a breeding area.

Results from the monitoring of Natura2000 areas as well as from the monitoring of offshore wind farms have shown a high occurrence of harbour porpoise in protected areas until 2013, especially in the area of the Sylter Außenfiff (GILLES ET AL., 2013, GILLES ET AL., 2019). However, current findings from the monitoring of Natura2000 areas show a change in populations in the German EEZ, which also particularly affects the nature conservation area "Sylter Außenriff – Östliche Deutsche Bucht" (GILLES ET AL. 2019, NACHTSHEIM ET AL., 2020).

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

As part of the noise abatement concept for the North Sea (BMU, 2013), a main concentration area of harbour porpoises in the summer months of May to August inclusive was identified west of Sylt on the basis of data from the period 2005 to 2010 inclusive. The main concentration area comprises the nature conservation area "Sylt Outer Reef – Eastern German Bight and areas to the west and northwest of it.

Figure 38 shows the main concentration area of harbour porpoises in the German EEZ identified in the BMU's noise abatement concept (2013).

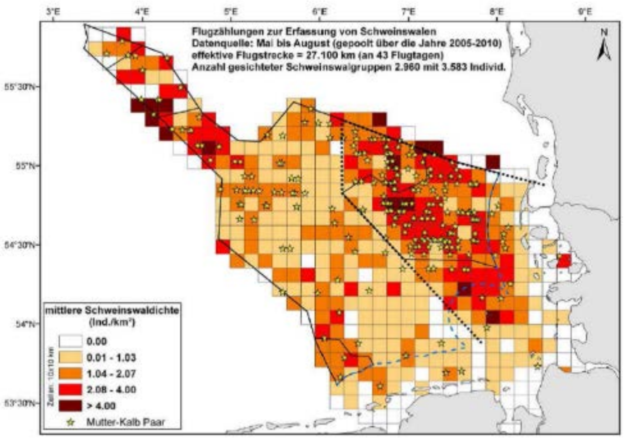


Figure 38: Raster representation of the distribution of harbour porpoises in the German North Sea and sightings of mother-calf pairs (Gilles, unpublished, cited in BMU, 2013).

The main area of concentration is defined as a reservation area for harbour porpoises because of its particular importance for the conservation of the population. The special importance of the reservation area results from the regular occurrence of harbour porpoise in the summer months and in particular from the occurrence of mother-calf pairs within this area. Depending on the weather, the nutrient-rich frontal system running west of the North Frisian coast extends in the area of the reservation and creates high-quality habitats for marine predators. The distribution patterns of harbour porpoises and in particular of mother-calf pairs within the reservation area vary between years depending on hydrographic conditions and associated nutrient availability. The variability of occurrence within the reservation area may reflect the spatial and temporal extent of the frontal system, as shown in Chapter 3.2.5 (Fronts).

Occurrence in priority areas EN1, EN2, and EN3

Information on the occurrence of marine mammals in the EN1, EN2 and EN-3 priority areas for the period 2008 to 2012 is provided by the investigations carried out during the third year of the investigation and the construction and operational monitoring of the "alpha ventus" project. For this purpose, extensive airborne surveys of marine mammals according to the 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 using underwater acoustic detectors also took place during the investigations (ROSE et al. 2014).

In the period 2009-2012, additional surveys of marine mammals were conducted for the "alpha ventus" test site as part of the accompanying ecological research (StUKplus project). The study area of the airborne surveys covered a large area of the plan area. Here, too, the focus of ecological research was on recording the effects of the noise-intensive pile driving and on recording possible behavioural reactions of harbour porpoises to the wind turbines in operation. The highest densities were always found to the west of areas EN2 and EN3 in the "Borkum Reef Ground" nature conservation area. 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 studies have been carried out as per the BSH standard for investigating the impact of offshore wind turbines on the marine environment (StUK4) in the area north of the East Frisian islands. The entire EN1, EN2 and EN3 areas are included in the large area under review of the cluster North of Borkum, in which nine wind farms have been erected between 2009 and 2018 and six of which are already in regular operation. This provides up-to-date data on the occurrence of harbour porpoises and on possible impacts from construction and operation phases of the wind farms already implemented in the entire area north of Borkum.

Findings from the construction and operational monitoring of 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 Natura 2000 sites indicate intensive use of the environment by harbour porpoises. The highest densities were always found to the west of the project area in the "Borkum Reef Ground" nature conservation area. 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 of the cluster studies "North of Borkum" have shown a change in the occurrence of harbour porpoises since 2014, with a tendency towards lower densities (Krumpel et al., 2017, Krumpel et al., 2018, Krumpel et al., 2019). The results of the cluster studies north of the traffic separation areas, north of Helgoland and north of Amrumbank also indicate a trend towards lower harbour porpoise densities since 2013. The results of the cluster studies "North of Borkum" thus fit into the overall picture of changes in the occurrence of harbour porpoises in the German North Sea EEZ and in the southern North Sea. Compared to the occurrence of harbour porpoises in other areas of the German North Sea EEZ, however, the changes are smallest in the area north of Borkum. The entire area north of Borkum with the "Borkum Reef Ground" nature conservation area and the three areas for offshore wind energy utilisation N-1, N-2 and N-3 also show a relatively high and stable occurrence of harbour porpoises in the years 2013 to 2018.

The data from the acoustic survey of harbour porpoises in the "Northern Borkum" cluster studies also show continuous use of the area by harbour porpoises, which is also more intensive in spring and summer. The results from visual and acoustic surveys of the cluster studies also confirm a higher abundance and use by harbour porpoises in the western part of the study area, in particular the FFH area "Borkum Reef Ground". The abundance of harbour porpoises and habitat use decreases in the area north of Borkum towards the east, with occasional high densities being found in various sub-areas. 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).

Within the framework of the large-scale survey of 2016, SCANS III showed a further shift of the stock from the southeastern area of the North Sea more towards the south-western area in the direction of the English Channel (Hammond et al., 2017). An initial analysis of research data and data from the national monitoring of nature conservation areas also suggests a shift in the population; the authors consided several factors as possible reasons for the observed change (GILLES ET AL., 2019). The results of visual and acoustic surveys also confirm that there is still a higher abundance and use by harbour porpoises in the western part of the study area, in particular the Borkum Reef Ground Habitat Area. The abundance and use seem to decrease towards the east.

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

The EN4 reservation area is located in the study area C_South of the monitoring of Natura 2000 sites. The findings from the monitoring on behalf of the Federal Agency for Nature Conservation (BfN) confirm lower densities in EN4 area compared to area C_North of the monitoring, in which area N-5 is located. In contrast to the low occurrence of harbour porpoises in the monitoring area C_South, the monitoring area C_North with sub-area I of the "Sylt Outer Reef - Eastern German Bight" nature conservation area shows high seasonal densities in late spring and summer. In summer 2009, for example, an average density of 0.58 ind./km^2 was recorded in the indirect vicinity of area N-4, while in sub-area I of the "Sylt Outer Reef – Eastern German Bight" nature conservation area the average density of 1.64 ind./km^2 was almost three times as high (including the monitoring report on marine mammals by BfN , 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 area EN4 was only 0.50 ind./km^2, which was significantly lower than in the study area C-North and in sub-area I of the *nature reserve "Sylt Outer Reef - Eastern German Bight" with 2.89 ind./km^2 (Monitoring report of BfN - Marine Mammals, 2011–2012).

In the course of the investigations of the cluster "North of Helgoland" for the three wind farms "Meerwind Süd/Ost" (Sea Wind South/East), "NordseeOst" (North Sea East), and "Amrumbank West", which are also located in the EN4 area, it was shown that harbour porpoises use this area evenly and continuously, independent of the construction and operation of the wind farms. While acoustic surveys using CPODs show a weak positive trend at some long-term stations, investigations using digital survey show a lower occurrence in 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 Reservation areas EN5

The sub-areas of the EN5 reservation area are regularly used by harbour porpoises for crossing and staying as well as for feeding and breeding. All studies in the area of cluster 5 from research projects such as MINOS, MINOSplus and SCANS surveys, from EISs and monitoring for offshore wind farm projects, and from monitoring of Natura 2000 sites always confirm a high calf population in the summer months. Due to the high proportion of sighted calves, the waters to the west of Sylt are considered to be the breeding grounds for harbour porpoises. The N-5 area is therefore part of a large area used as a feeding and breeding ground for harbour porpoises.

Current findings from the monitoring of Natura 2000 sites on behalf of the BfN also confirm high seasonal densities in late spring and summer in the area of the sub-areas of the EN5 site. The EN5 area is located in area C_North of the study area for the Natura 2000 sites. In 2008, an average density of 2.28 ind./km² was determined for the study area C_North (Monitoring report of the BfN - Marine Mammals, 2008-2009). In summer 2009, the density in the area C_North was only 1.64 ind./ km² (Monitoring report of BfN - Marine Mammals, 2009-2010). In June 2010 a density of 2.12 ind./ km² was recorded again (Monitoring report of BfN - Marine Mammals, 2010-2011).

These values were also confirmed by monitoring in the following years. The abundance for the study area C_North amounted to 23,163 animals in May 2012. This corresponds to an average density of 2.89 ind./km², which was significantly higher than in the adjoining study area C_South (Monitoring report of BfN - Marine Mammals, 2011-2012, 2014-2015).

Extensive information is also provided by the surveys carried out as part of the monitoring of the “DanTysk”, “Sandbank”, and “Butendiek” wind farm projects: Over the entire survey period, porpoises were sighted in the survey area “DanTysk/Sandbank”, western area of Area EN5, with a total of 1,702 animals surveyed in 2011. The highest occurrence was mainly observed in summer. The average density in the summer months was 3.8 individuals per km² and the proportion of calves varied between 10 and 25%. The highest calf percentages were found in the months of June, July, and August (BioConsult SH 2012a).

In the "Butendiek" study area immediately to the east, it was found that from September to March, harbour porpoise numbers remained low and did not increase until the end of April. High densities, on the other hand, were observed in the summer months. The highest density of 5.9 individuals per km² was recorded in June. The calculated mean density in summer was 2.2 individuals/km², which was within the range of densities recorded during BfN monitoring (BioConsult SH 2012b). Within the scope of the high-frequency investigations for both areas under review of the projects "DanTysk" and "Butendiek" described here, the high variability of occurrence between the individual investigation days in summer was striking.

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, following a slight decline in harbour porpoise numbers between the first years of baseline surveys (2001–

2003) and the 3rd investigation year of the baseline surveys (2011), a clear trend is not evident. This observation is supported by literature data and indicates a longer-term summer population shift of harbour porpoises between 2003 and 2013 from coastal areas of the eastern North Sea towards the west. However, as this decrease started well before construction began, the construction and operation of the wind farm is not related to this. The continuous data from acoustic monitoring using C-PODs show the highest detection rates determined in late spring and early summer; in contrast to the other investigation methods, acoustic monitoring also revealed high detection rates at some stations in autumn. Trend analyses of the permanent C-POD stations in thearea under review confirm the results from flight and ship surveys of the last years and shows a weak positive trend over the last five years. Overall, the data from all survey methods show that harbour porpoises are continuously present throughout Area 5 and their occurrence follows a relatively stable phenological pattern over the years. On a small scale, however, there are considerable spatial and temporal fluctuations. Because of these fluctuations, the increased migration into the area from April/May onwards and the occurrence of calves at the same time as high summer densities, this area of the EEZ can still be considered an important feeding and reproduction area (BioConsult SH 2018).

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

Up-to-date information on the occurrence of harbour porpoises in the German EEZ sub-area 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", "German Bight" as well as "EnBW Hohe See" and "Albatros". Higher densities occur mainly in spring and late summer, low densities mainly in autumn and early winter. The annual average absolute frequencies in the years 2008 to 2013 with values between 0.34 individuals/km² and 0.98 individuals/km² are slightly to significantly above the values determined in the years 2004-2006. In the course of the year, average densities of 0.5 harbour porpoises/km² can be expected 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 to date confirm the occurrence. In addition, the results of the acoustic monitoring indicate that high harbour porpoise activity also occurs in the winter months. The proportion of calves recorded in the years 2008-2013 still does not suggest that the area is of particular importance for the reproduction of the species. While the abundance of harbour porpoises was relatively stable in the years 2005 to 2012, it decreased in the following years. It is only from the end of 2016 onwards that a steady increase in the occurrence of harbour porpoises in the central part of the German EEZ in the North Sea is becoming 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 OWP's "BARD Offshore I", "Veja Mate" and "German Bight", PGU 2017, environmental monitoring in the cluster "East of Austerngrund" Annual Report 2016 - April 2015 - March 2016).

Occurrence in Reservation areas *EN14 to EN19*

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

The entire area of the reservation areas EN14 to EN19 has not yet been investigated as intensively as the areas EN1 to EN13 described above. There are only individual surveys within the framework of the monitoring for the "Dogger Bank" nature conservation area, which also provide information on these areas (BfN, 2012, BfN 2014). As part of the monitoring of the Natura 2000 sites, an exceptionally high occurrence of harbour porpoises was recorded in May 2012 in this area of the German EEZ, which was even higher than in the area of the Natura 2000 site "Sylt Outer Reef" or area I of the "Sylt Outer Reef – Eastern German Bight" nature conservation area. However, the observations in 2012 remained exceptional overall due to comparatively lower densities in the summer months in the nature conservation areas. Investigations carried out in 2009, 2013 and 2015, as part of research projects, among other things, show that the EN19 area tends to be the peripheral area of the main distribution range of harbour porpoises from the west coast of the UK to Dogger Bank (Gilles et al. 2012, Geelhoed et al. 2014, Cucknell et al. 2017).

The occurrence of harbour porpoises in the EN14 to EN19 reservation areas can be determined using habitat modelling based on data from 2006 to 2013 inclusive and from the contiguous habitat of harbour porpoises in the North Sea (Gilles et al., 2016).

Taking into account all available data up to and including 2013, the habitat modelling shows that the areas EN14 to EN18 are among the areas of the North Sea with lower harbour porpoise abundance. In contrast, EN19 is located at the edge of the large contiguous high-density harbour porpoise range east of the British Isles, which extends to Dogger Bank.

The distribution of harbour porpoises in the German North Sea EEZ based on current data for the years 2012 to 2018 inclusive from monitoring of the nature conservation areas and from research projects also confirms a low occurrence in areas EN14 to EN18 inclusive and a comparatively higher occurrence in the "Dogger Bank" nature conservation area and 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 the coastal regions throughout the North Sea. Throughout the Wadden Sea, regular aerial surveys are carried out at the height of the change of coat in August. In 2005, 14,275 seals were counted throughout the Wadden Sea (ABT et al. 2005). As there is always a part of the animals in the water and not counted, this is the minimum population.

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

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

Strong seasonal fluctuations are reported (ABT et al. 2002, ABT 2004). The numbers observed in German waters must be seen in a broader geographical context because grey seals sometimes undertake very long migrations between different resting sites throughout the North Sea region (MCCONNELL et al. 1999). The grey seals observed in the resting places in coastal waters probably have their feeding grounds partly in the EEZ.

The compilation of the BfN data sources 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 the protected asset marine mammals

The harbour porpoise is the key species in the German waters of the North Sea that is used in the BMU's noise abatement concept (2013) to assess the potential impacts of impulsive noise inputs. Furthermore, within the framework of the implementation of the MSFD, the harbour porpoise is the indicator species for assessing cumulative impacts of uses and, finally, for assessing good environmental status in the OSPAR area.

The population of harbour porpoises in the North Sea has decreased over the last centuries. The general situation of the harbour porpoise has already deteriorated in earlier times. In the North Sea, the population has declined mainly due to by-catch, pollution, noise, over-fishing and food restrictions (ASCOBANS 2005). However, there is a lack of concrete data to calculate or forecast trends. 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 making abundance or population calculations based on aerial surveys or even field trips, the authors caution 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 more difficult in particular 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).

The statistical evaluation of data from the large-scale surveys carried out as part of research projects and, since 2008, as part of the monitoring of Natura 2000 sites on behalf of the Federal Agency for Nature Conservation (BfN) indicates a significant increase in harbour porpoise densities in the southern German North Sea between 2002 and 2012. In the area of Sylter Außenriff, the trend analysis also indicates stable populations in summer over the years 2002 to 2012 (GILLES et al. 2013). The western area in particular shows a positive trend for spring and summer, while no clear trend can be detected in autumn. Harbour porpoise densities in the eastern area have remained largely constant over the years and significant differences between the hotspots in the west and lower density in the southeastern German Bight have been found.

Current findings from the large-scale cluster studies of offshore wind farms do not provide any indication of a decreasing trend in the abundance of harbour porpoise or of changes in seasonal distribution patterns in the German North Sea EEZ from 2001 to the present. The multiannual data from the CPOD station network confirm a continuous use of the habitats 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 German waters in the North Sea based on data from monitoring of nature conservation areas and research projects for the years 2012 to 2018 has shown a stock shift. Declining trends were observed in the "Sylt Outer Reef - Eastern German Bight" and "Dogger Bank" nature conservation areas as well as in the central area of the German Bight. In contrast, a positive trend has emerged in the "Borkum Reef Ground" nature conservation area and in the EN1, EN2, and EN3 areas. The causes of the stock shift are not yet known and could be related to both the impacts of human activities and shifts in the fish stocks (GILLES ET AL., 2019, NACHTSHEIM ET AL., 2020).

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

According to the current state of knowledge, it can be assumed that the German EEZ is used by harbour porpoises for traversing, staying and also as a food and area-specific breeding ground. Based on the knowledge available, it can be concluded that the EEZ is of medium to high importance for harbour porpoises in certain 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 hydrographic conditions and food supply. It is therefore not very useful to consider the importance of individual sites such as the sites covered by the plan or individual wind farm sites. In the following, the importance of areas that belong to a natural area unit and that were additionally covered by intensive project-related studies will be assessed separately.

Priority areas EN1, EN2, and EN3

According to current knowledge, priority areas EN1 to EN3 are of medium to - seasonal in spring - high importance for harbour porpoises. The investigations carried out as part of the monitoring of the Natura 2000 sites and as part of the monitoring for the offshore wind farm projects always confirm a significantly higher occurrence in the "Borkum Reef Ground" conservation area with decreasing densities in an easterly direction.

- The areas are used by harbour porpoises all year round for crossing, staying and probably for feeding.
- 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.
- The sightings of calves in the areas are rather sporadic and irregular and therefore most likely exclude the use of the area as a rearing area.
- There is no evidence of a continuous specific function of areas EN1, EN2 and EN3 for harbour porpoises.

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

Reservation area EN4 and priority area EN13

According to the current state of 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 by harbour porpoises all year round for crossing, staying and probably for feeding.
- 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 west of Sylt (area EN5)
- Regular sightings of calves in these areas, albeit in comparatively small numbers, suggest that these areas should be considered

as peripheral to the large rearing area in the German North Sea EEZ.
- Because of their function as feeding and occasionally nursery areas, Areas EN4 and EN13 are of medium to seasonal high importance for harbour porpoises.

The EN4 area is located at the western edge of the distribution area 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.

Reservation area EN5

The EN5 area is regularly used by harbour porpoises for crossing and staying as well as for feeding and breeding.

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

- The area is used by harbour porpoises all year round for crossing, staying and feeding.
- Harbour porpoise use of the EN5 area is particularly intensive in summer.
- The EN5 area is used by harbour porpoises as a breeding ground during the summer months.
- The density of harbour porpoises in this area is high compared to other areas of the EEZ.
- The EN5 area is of great importance for harbour porpoises, especially as a feeding and breeding ground.

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

Priority areas EN6 to EN12

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

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

- The areas are used by harbour porpoises all year round for crossing, staying and probably for feeding.
- 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 individual mother-calf pairs precludes the use of these areas as a rearing ground with a high 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 because of the distance to the nearest resting and littering sites.

Reservation areas EN14 to EN19

The data available for the reservation areas EN14 to EN19 is not sufficient to assess the occurrence of harbour porpoise and the importance of the areas. There is a lack of systematic studies to date to capture seasonal patterns, variability between years and abundance. Based on the available data, it can be assumed that EN19 is of medium importance for the reserve area and that it is of high seasonal - summer - importance.

- The EN14 to EN18 reservation areas are used by harbour porpoises all year round for crossing, staying and probably for feeding.

- The occurrence of harbour porpoises in these areas is average compared to the high occurrence in the waters west of Sylt.
- The abundance of harbour porpoises in the surrounding EN19 reserve is higher during the summer months.
- Mother and calf pairs occur in the EN19 reserve during the summer months.

For the two seal species, the reservation areas are of no particular importance due to the distance to the nearest resting and whelping areas.

2.8.3.2 Protection status

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

Harbour porpoises are protected under several international conservation agreements. They fall under the conservation 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 conserve the species. The harbour porpoise is listed in both Appendix II and Appendix IV of the Habitats Directive. As a species listed in Annex IV, it enjoys strict general protection under Articles 12 and 16 of the Habitats Directive.

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

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

In Germany, the harbour porpoise is listed in the Red List of Threatened* Animals (Meinig et al., 2020). Here it is classified in treat category 2 (endangered). The authors point out that the threat classification for Germany results from the joint consideration of threats in the North Sea and the Baltic Sea. The occurrence in the North Sea is surveyed by ship- and aircraft-based investigations and is described as stable. In the Borkum-Riffgrund nature conservation area, there is a slight increase in abundance (Peschko et al. 2016, cited in Meining et al., 2020). However, because of ongoing threat from by-catch in gillnets, environmental toxins, and noise, the authors have concluded to classify the status as “Threatened” despite the overall stable short-term population trend (Meinig et al., 2020). Investigations 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 stock of the separate population of harbour porpoise in the central Baltic Sea is only approx. 500 animals (SAMBAH 2016). For this reason, this sub-population is classified as “critically endangered”.

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

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

The seal is classified in category G (indeterminate). The authors confirm that there are two separate populations in the German North Sea and Baltic Sea. The population present in the German North Sea has recorded an increase in juveniles since 2013 and, after two distemper virus epidemics, would be classified as “least concern” unlike the population of the German Baltic Sea (Meinig et al., 2020).

Based on the results of the research projects MINOS and EMSON, three areas that are of particular importance for harbour porpoises were defined in the German EEZ. These were notified to the EU as offshore protected areas in accordance with the Habitats Directive and recognised by the EU as Sites of Community Importance (SCI) in November 2007: Doggerbank (DE 1003-301), Borkum Riffgrund (DE 2104-301), and especially Sylter Außenriff (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 dated 22 September 2017,
- Ordinance on the Establishment of the "Doggerbank" Nature Conservation Area (NSGDgbV), Federal Law Gazette I, I p. 3400 dated 22 September 2017,
- Ordinance on the Establishment of the Nature Conservation Area "Sylter Außenriff – Östliche Deutsche Bucht" (NSGSylV), Federal Law Gazette I, I p. 3423 dated 22 September 2017.

The conservation objectives 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 Appendix 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. Federal Law Gazette I, I p. 3395, NSGDgbV), Federal Law Gazette I, I p. 3400 dated 22 September 2017, NSGSylV), Federal Law Gazette I, I p. 3423 dated 22 September 2017).

2.8.3.3 Legacy impacts

The North Sea harbour porpoise population is affected by a wide range of anthropogenic activities, changes in the marine ecosystem, diseases and climate change.

Legacy impacts on marine mammals result from fishing, attacks by dolphin-like creatures, physiological effects on reproduction, diseases possibly related to high levels of pollution and underwater noise. The main endangerment for harbour porpoise stocks in the North Sea results from fishing, through by-catch in bottom trawls and bottom-set gillnets, depletion of prey fish stocks through over-fishing and the resulting reduction in food availability (Evans, 2020). An analysis of dead and stranded fish from the British Isles between 1991 and 2010 has identified the causes as follows: 23% infectious diseases, 19% attacks by dolphins, 17% by-catch, 15% starvation and 4% were stranded alive (Evans, 2020).

Current anthropogenic uses in the areas' vicinity with noise pollution include shipping, seismic exploration, military use and the detonation of non-transportable ammunition. The endangerment of 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 means of pile driving, if no mitigation or preventive measures are taken.

In addition to impacts caused by the discharge of organic and inorganic pollutants or oil spills, the stock is also endangered by diseases (of bacterial or viral origin) and climate change (especially impacts on the marine food chain).

2.9 Seabirds and resting birds

According to the "Qualitätsstandards für den Gebrauch vogelkundlicher Daten in raumbedeutsamen Planungen" (Quality standards for the use of ornithological data in spatial 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 birds are defined as birds “that regularly forage in the investigated area, do not breed there, but breed or could breed in the wider region” (GERMAN ORNITHOLOGISTS’ SOCIETY 1995).

Seabirds are bird species for which the way of life is predominantly bound to the sea and which come ashore only for a short time to breed. These include, for example, Northern fulmar, Northern gannet, and auks (guillemot, razorbill). Terns and gulls, on the other hand, have a distribution that is mostly closer to the coast than seabirds.

2.9.1 Data situation

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

The findings on the spatial and temporal variability of seabird abundance in the southern North Sea are based on surveys by ESAS (European Seabirds at Sea) and on several spatially and temporally limited research projects (e.g. MINOS, MINOSplus, EMSON, StUKplus, HELBIRD, DIVER, TOPMarine). In recent years, the database has expanded considerably due to a large number of new investigation programmes for monitoring the Natura 2000 areas, within the framework of environmental impact studies, monitoring of offshore wind farm projects during construction and operation, but also research projects and studies focusing on scientific evaluation of existing data in the German North Sea EEZ. The existing data sources 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 no comprehensive data are 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 therefore able to cross large areas during their search for food or to track species-specific prey organisms such as fish over long distances. This high mobility - depending on the specific conditions of the marine environment - leads to a high degree of spatial and temporal variability in the occurrence of seabirds. The distribution and abundance of birds vary over the course of the seasons.

The distribution of seabirds in the German Bight is determined in particular by the distance from the coast or breeding grounds, hydrographic conditions, water depth, the composition of the bottom and the food supply. In addition, the occurrence of seabirds is influenced by strong natural events (e.g. storms) and anthropogenic factors such as nutrient and pollutant inputs, shipping and fisheries. Seabirds, as consumers at the top of the food chain, 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 territorial waters and parts of the EEZ of the North Sea are of great importance for seabirds and waterbirds (as a number of studies have shown not only nationally but also internationally) and were identified as areas of special importance for seabirds, “Important Bird Areas - IBA” early on (SKOV et al. 1995, HEATH & EVANS 2000). Particular mention should be made here of sub-area II of the “Sylter Außenriff – Östliche Deutsche Bucht” nature conservation area established by ordinance of 22 September 2017, which was already designated as a Special Protected Area (SPA) by ordinance of 15 September 2005: Special Protected Area (SPA)) in accordance with V-RL (79/409/EEC).

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

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

There are 19 species of seabirds in the German North Sea EEZ, which are regularly recorded as resting birds in larger populations. Table 11 contains 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 seasons with the highest occurrence 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).

(2008). ***Name*)**	**Season**	**Stock German North Sea**	**Stock German EEZ**
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
Northern gannet (*Morus bassanus*)	Summer	1,400	1,200
Great black-backed gull (*Larus marinus*)	Winter	15,500	9,000
	Autumn	16,500	9,500
Lesser black-backed gull (*Larus fuscus*)	Summer	76,000	29,000
	Autumn	33,000	14,500
Common gull (*Larus canus*)	Winter	50,000	10,000
Little gull (*Hydrocoloeus minutus*)	Winter	1,100	450
Kittiwake (*Rissa tridactyla)*	Winter	14,000	11,000
	Summer	20,000	8,500
Sandwich tern (*Thalasseus sandvicen-sis*)	Summer	21,000	130
	Autumn	3,500	110
Common tern (*Sterna hirundo*)	Summer	19,500	0
	Autumn	5,800	800
Arctic tern (*Sterna paradisaea*)	Summer	15,500	210
	Autumn	3,100	1,700
Razorbill (*Alca torda*)	Winter	7,500	4,500
	Spring	850	800
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 Sylt Outer Reef – Eastern German Bight Nature Conservation Area

The occurrence of seabirds shows a very high spatial and temporal variability. Long-term observations or systematic censuses 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 examined individually due to species-specific differences in spatial and temporal distribution.

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

The two types cannot always be reliably distinguished from each other in airborne and ship-borne counts. For this reason, the two species are presented together in this case. According to all findings to date, the proportion of black-throated divers is approx. 8 to 11%.

Sea divers are regularly found along the coast of the southeastern North Sea in winter. Towards spring, the main portion of the population shifts further to the north, especially to the area west of Sylt. At this time of year, the distribution reaches almost 100 km into the EEZ (Mendel et al. 2008). On the basis of many years of data collection in the German EEZ, a main distribution area (main concentration area) of loons was identified and defined off the North Frisian islands in spring (BMU 2009). An evaluation of data from research projects, environmental impact studies and monitoring of offshore wind farm projects from 2000 to 2013 prior to the construction of the wind farms showed that the seasonal distribution of loons in the German Bight had remained largely constant over a longer period of time. At the same time, there was a clear expansion of the occurrence of divers in a westerly direction, thereby confirming the importance of the main concentration area (Garthe et al. 2015). A study by the FTZ conducted on behalf of the BSH and the BfN, which, in addition to the data sources of the 2015 study, takes into consideration data from the construction and operational phases of the offshore wind farm projects in 2014–2017, shows a shift in diver incidence after construction of the wind farms in the central portion of the main concentration area furthest away from the implemented projects (Garthe et al. 2018, Garthe et al. 2019, Figure 33). A recent study commissioned by the Bundesverband der Windparkbetreiber Offshore e.V. (BWO) confirms this observation (BioConsult SH et al. 2020).

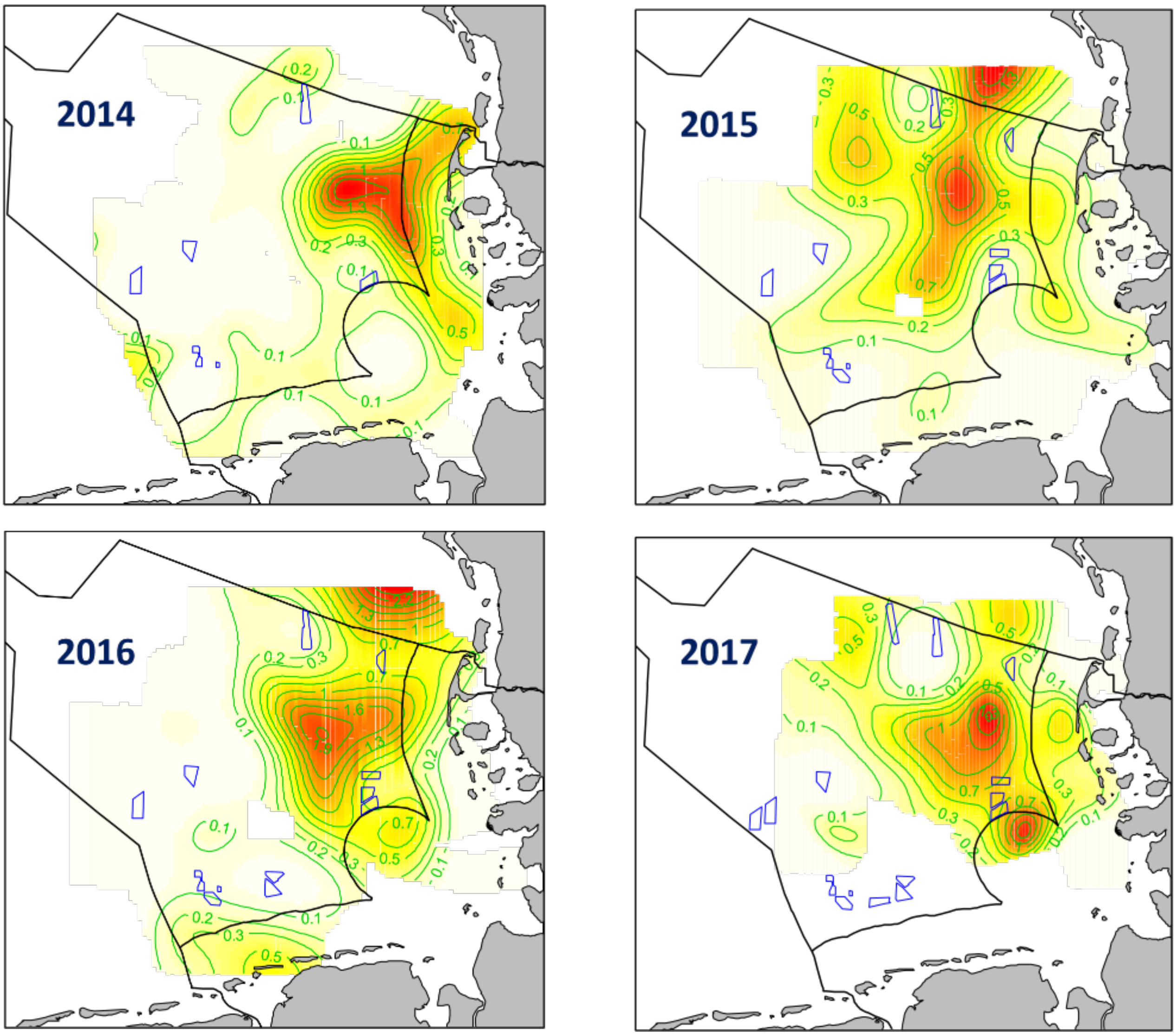


Figure 33: Interpolated loon densities in the German Bight in spring 2014 - 2017. The offshore wind farm projects in operation at the time of data collection are outlined in blue. Numbers indicate interpolated densities (GARTHE et al. 2019).

Little Gull (*Larus minutus*)

The Deutsche Bucht, where the little gull reaches only low population densities, is located at the north-eastern edge of the winter distribution of European little gull (GLUTZ von BLOTZHEIM & BAUER 1982). In general, a considerable proportion of the Northwest European population flies over the coastal areas of the German North Sea coast during migration and return, as long-term observations from research projects and EIAs unanimously show. 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 remain in the German EEZ (MENDEL et al. 2008). The large number of individuals during migration is then followed by a lower, constant winter occurrence in the German North Sea, which is predominantly restricted to the territorial sea, the "Sylt Outer Reef - Eastern German Bight" and the "Borkum Reef Ground" nature conservation areas. In general, their occurrence depends strongly on the prevailing weather.

<u>Sandwich tern (*Thalasseus sandvicensis*)</u>

The distribution area of the sandwich tern in the pre-breeding period, 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 long-term data series of the FTZ show the main occurrence of the sandwich tern in the German North Sea in the summer half of the year. Sandwich terns then occur in large areas of the entire territorial sea. In the area outside the territorial waters, Sandwich terns occur only sporadically (MENDEL et al. 2008). In areas with a water depth of more than 20 m, there are hardly any terns searching for food.

<u>Common tern (*Sterna hirundo*) and Arctic tern (*S. paradisaea*)</u>

Common and Arctic terns cannot always be reliably distinguished under unfavourable observation conditions and are therefore treated together. Both common and Arctic terns spend the breeding season in a strip off the coast, which only extends slightly into the EEZ in the northern part. Highest densities are found near the breeding sites on the offshore islands. The distribution of the two species of terns after the breeding season is very similar to that during the breeding season. However, local centres of gravity 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).

<u>Common Guillemot (*Uria aalge*)</u>

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 around 2,811 breeding pairs (BMU 2020). During the breeding season, birds only leave the colony to forage for food within a radius of max. 30 km. The presence of the common guillemot is therefore concentrated during the breeding season in the German Bight and the spatial surroundings of the breeding colony on Helgoland. Further north-west, guillemots occur only in low densities at this time of year (MENDEL et al. 2008).

From late summer and autumn onwards, the occurrence of the guillemot shifts to offshore areas with water depths between 40–50 m up to the “Duck’s Bill” of the German EEZ (MARKONES & GARTHE 2011, BORKENHAGEN et al. 2018) (see Figure 34). During this period, adult birds are frequently observed with their young, although these are most likely to come from British breeding colonies.

In winter, guillemots reach the highest densities and occur almost everywhere in the German EEZ of the North Sea (MENDEL et al. 2008). According to current state of 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.

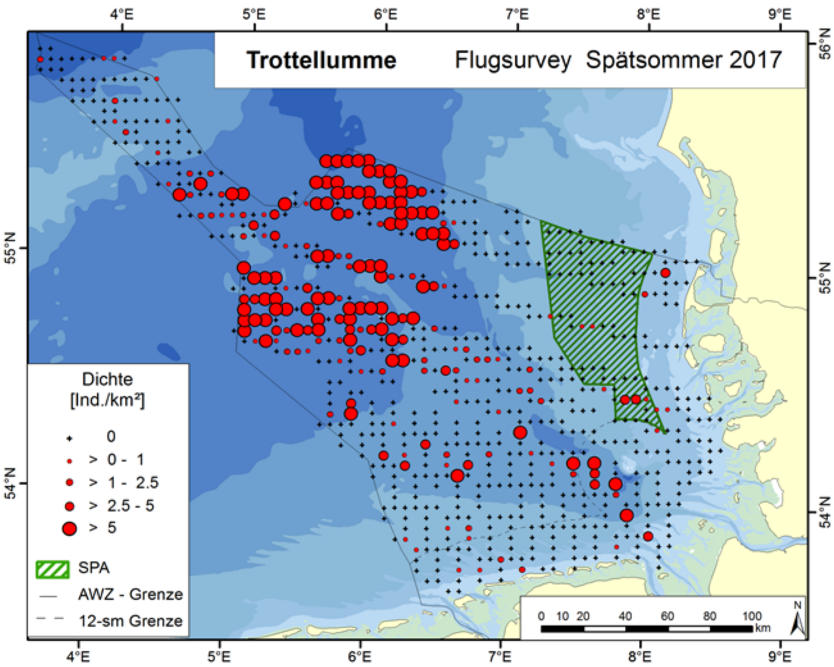


Figure 34: Distribution of guillemots in the Deutsche Bucht in late summer 2017. Based on four aerial surveys in the period from 11 to 30 August 2017 and one survey on 3 September 2017 (BORKENHAGEN et al. 2018)

Razorbill (*Alca torda*)

Razorbills are relatively common in winter in the coastal waters of the EEZ. A significant 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 long-term data series of the FTZ confirm the main occurrence of razorbill 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).

Northern gannet (*Sula bassana*)

Northern gannets are found in large parts of the German North Sea in low densities without any particular concentrations being detected. This is confirmed by more recent investigations (MARKONES et al. 2014, MARKONES et al. 2015). Despite the currently observed increase, Helgoland's breeding colony is too small to be clearly noticeable at sea. The long-term data series of the FTZ indicate a year-round, albeit low, occurrence of the Northern gannet in the entire Deutsche Bucht (MENDEL et al. 2008).

Northern fulmar (*Fulmarus glacialis*)

Fulmars occur in the German North Sea all year round and almost everywhere. They occur in higher densities in areas far from the coast than in areas close to the coast (MARKONES et al. 2015, BORKENHAGEN et al. 2018). The long-term data of 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). In the course of baseline surveys for offshore wind farm projects, it was also determined that kingfishers 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 the populations at sea. Fulmars are regularly found in high densities at a distance of over 70 km from the coast, especially in summer.

Greater black-backed gull (*Larus marinus*)

Great black-backed gulls are present all year round in the German North Sea. In low densities, they occur in spring and summer both near and far from the coast, 80 km from the coast. In autumn, the occurrence then increases steadily, leading to a high number of wintering grounds in the Elbe estuary and along the East Frisian coast. In the offshore area, only isolated black-backed gulls* occur (MENDEL et al. 2008). A current trend analysis based on comprehensive transect surveys from 1990 to 2013 showed a significantly negative population development of the great black-backed gull in the North Sea. However, the reason for this is not a decrease in the breeding population but rather an increasing shift in resting occurrences and a decreasing importance of marine food sources (MARKONES et al. 2015).

Lesser black-backed gull (*Larus fuscus*)

During the migration home and in the pre-breeding period, the distribution of herring gulls is concentrated around 60 km off the coast. Both during and after the breeding season, the lesser black-backed gull is a widespread species in the Deutsche Bucht. Focal points are the territorial waters off Schleswig-Holstein and Lower Saxony as well as the adjacent areas of the EEZ, especially west of the island of Helgoland. The lesser black-backed gull is a well-known ship follower. Its sometimes highly concentrated occurrence can therefore often be observed in connection with fishing activity. In the area around the island of Helgoland, the lesser black-backed gull is the only seabird species to occur in high densities during the summer months and is the most common seabird species in the German North Sea during this period. Recent studies show, as for the Great Black-backed Gull, a decrease in the summer occurrence of the lesser black-backed gull in the German North Sea. However, this is not due to a decline in the breeding population but rather a shift in occurrence to terrestrial areas (MARKONES et al. 2015).

Kittiwake (*Rissa tridactyla*)

Along with herring gulls and guillemots, kittiwakes are among the most common species in the German North Sea EEZ and occur all year round. The long-term data series of the FTZ indicate a clearly concentrated occurrence around Helgoland in spring and summer and also in a north-west 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 continues to spread to areas far from the coast. In winter, the occurrence increases in coastal areas; however, 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 investigations within the framework of seabird monitoring on behalf of the BfN (MARKONES et al. 2014).

Common gull (*Larus canus*)

Gulls are widespread in the eastern and southern part of the German Bight near the coast in winter. The highest densities are found in the Elbe-Weser estuary, in the area of the Ems estuary and off the North Frisian islands. The long-term data series of the FTZ indicate that gulls are present in the German North Sea all year round, but the largest populations in the off-shore area are reached in winter. The winter occurrence extends with high densities over the entire near-coastal area up to the 20 m depth contour. In areas far from the coast, common gulls still occur regularly but in significantly lower numbers (MENDEL et al. 2008). In the other seasons, common gulls stay closer to the coasts, where their breeding grounds are also located (see Figure 35). The occurrence of gulls is also highly dependent on the weather.

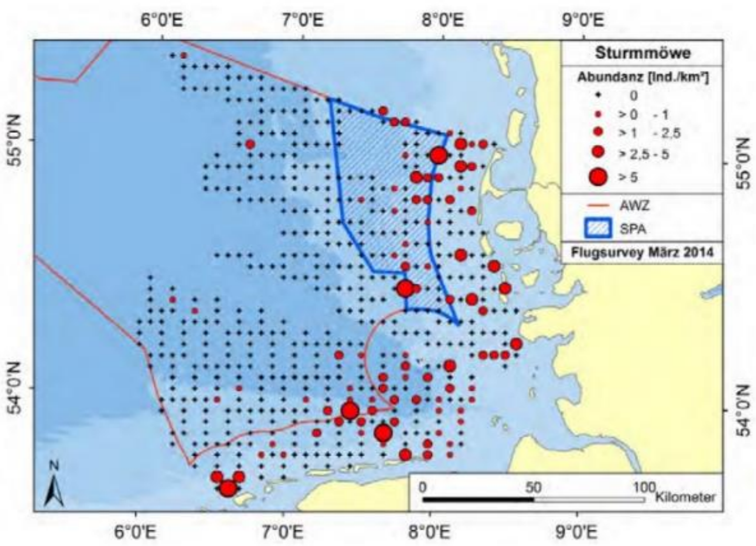


Figure 35: Occurrence of Common Gulls in the German North Sea - surveys from 4, 12, and 13 March 2014 (MARKONES et al. 2015).

Skua (*Stercorarius skua*)

Skuas are very rarely observed in the Deutsche Bucht (BORKENHAGEN et al. 2018). A sporadic occurrence is possible all year round, but there is a concentration during migration from late June to November. In the eastern part of the Deutsche Bucht, the occurrence is often observed in connection with strong westerly winds (DIERSCHKE et al. 2011).

Pomarine skua (*Stercorarius pomarinus*)

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

Black scoter (*Melanitta nigra*)

Scoters are found all year round in the German North Sea, but their occurrence is concentrated in coastal and shallower offshore areas. In spring and autumn, the migration patterns determine the occurrence of scoters. In winter, the coastal areas serve as important resting habitats, and in summer a moulting migration can be observed. The offshore bird conservation area "Östliche Deutsche Bucht" records very low populations only in summer and autumn compared with the entire German North Sea (MENDEL et al. 2008).

2.9.2.3 Occurrence of seabirds in the nature conservation area "Sylter Außenriff – Östliche Deutsche Bucht"

By decree of 22 September 2017, the nature conservation area (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 km^2. Subsection II of the NSG corresponds to the "Eastern German Bight" wild bird conservation area , which was designated as a nature conservation area with effect from 24.0.2005 and included in the list of Specially Protected Areas (SPA) as a wild bird conservation area (DE 1011-401). Sub-area II comprises a surface of 3,140 km^2. In sub-area II, a total of six species listed in Appendix I of the European Birds Directive are found: red-throated diver, black-throated diver, little gull, and Sandwich tern as well as the common tern and the Arctic tern. Regular migratory bird species include fulmar, gannet, common scoter, skua, pomarine gull, common gull, common gull, lesser black-backed gull, lesser black-backed gull, kittiwake, common guillemot, and razorbill (section 5 subsection 1 nos. 1 and 2 NSGSylV).

As part of the description and status assessment of the "Sylt Outer Reef - Eastern German Bight" nature conservation area (BfN 2017), species-specific stock 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 a tendency to occur closer to the coast, that the stocks are concentrated in sub-area II during the high season. with the exception of the red-throated diver stocks in spring Table 12, lists the populations determined in BfN (2017) for the species protected according to the conservation purpose of sub-area II in the seasons of high occurrence.

Table 12: Stocks of bird species protected in the "Sylt Outer Reef - Eastern German Bight" nature conservation area in the high season according to BfN (2017). Spring stocks of the red-throated diver in sub-area II according to Schwemmer et al (2019).

Common name (*scientific Name*)	**Season**	**Stock Nature conservation area “Sylter Außenriff – Östliche Deutsche Bucht”**
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
Lesser black-backed gull (*Larus fuscus*)	Autumn	4,700
	Summer	4,800
Common gull (*Larus canus*)	Winter	4,600
Black scoter (*Melanitta nigra*)	Winter	15,000
Razorbill (*Alca torda*)	Autumn	4,500
	Winter	2,000
Guillemot (*Uria aalge*)	Autumn	4,700
	Winter	6,000
Northern gannet (*Morus bassanus*)	Spring	330
	Summer	300

Common name (*scientific Name*)	Season	Stock Nature conservation area "Sylter Außenriff – Östliche Deutsche Bucht"
Fulmars (*Fulmarus glacialis*)	Spring	2,300
	Summer	2,700
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

On the basis of all data available in 2009 from environmental impact studies for offshore wind farms, from research projects and from Natura 2000 monitoring, the main concentration area of loons in the German Bight was defined (BMU 2009).

The main concentration area takes into account the spring period, which is particularly important for the species, red-throated and black-throated divers. On the basis of the data available at the time the main concentration area was stipulated in 2009, the main concentration area was home to around 66% of the loon population of the German North Sea and around 83% of the EEZ population in spring and is therefore particularly important from a population biology perspective (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 km^2. It includes all areas with a very high density of loons and most of the areas with a high density. The delineation of the main concentration area of divers is based on the data basis, which is considered to be very good, and on expert analyses that find broad scientific acceptance. From more detailed analyses and further studies, it is known that loon populations are subject to a high degree of temporal and spatial dynamics. The use of the different areas of the main concentration area can be related to the also very dynamic frontal systems in the eastern Deutsche Bucht (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. Particularly during the spring migration of the species from the wintering to the breeding areas, however, 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, but these are unlikely to form part of a larger, contiguous area regularly used at medium to very high density (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 utilisation 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 are available from environmental impact studies and the monitoring of offshore wind farm projects during construction and operation. The data are based on many years of ship- and airborne surveys. Due to the large-scale surveys, the findings from these studies can be assumed to be representative of the seabird communities in individual sub-areas or zones of the EEZ.

Areas EN1, EN2, EN3 (Zone 1)

The extensive investigations of seabirds 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 in areas EN1, EN2 and EN3 and their surroundings as would be expected for the prevailing water depths and hydrographic conditions, the distance from the coast, and the 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). The seabird population is dominated by seagulls, especially those known as ship followers, which benefit from fishing waste (e.g. lesser black-backed gull). Lesser black-backed gulls occur only sporadically, while common gulls occur independently of fishing activities in autumn and winter. Seabird species such as common guillemots and razorbills are among the most common species, along with kittiwake and herring gulls. On the other hand, coastal bird species such as terns and ducks are only found in small numbers and only flying during the main migration periods. For diving sea ducks, the areas are of no particular importance as feeding grounds due to the depth of the water. 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). Sea divers use this coastal area of the EEZ mainly in winter and spring. Studies show a concentrated distribution of loons within the 12-mile zone off the East Frisian Islands. However, they also occur sporadically* within and around areas EN1 to EN3(GARTHE et al. 2015, IFAÖ et al. 2016, IFAÖ et al. 2017, IfAÖ et al. 2018, IFAÖ et al. 2019b). Current FTZ assessments show a larger occurrence to the south-east of Area EN3 (GARTHE et al. 2018).

All in all, an examination of all available data suggests that the three sub-areas are used differently depending on the species. There are no discernible focal occurrences. 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 illustrate the strong interannual variability of bird occurrence in this area.

Area EN4 (Zone 1)

Data from the area surrounding EN4 show a medium and at times high occurrence of seabirds. The entire area of the eastern German Bight, where the EN4 area is also located, is of high importance for a total of six species (groups). These include red-throated diver, black-throated diver, little gulls, petrels, scoters and terns (common, coastal and burnt terns).

However, scoters are rarely if ever seen in the EN4 area due to the water depth of more than 20 m. In recent investigations, dense occurrences of black scoters have only been observed in the extreme north-eastern edge of the area of investigation of EN4 (IBL UMWELTPLANUNG et al. 2016b, IBL UMWELT planung et al. 2017a, IBL UMWELTPLANUNG et al. 2018). Common gulls occur in and around the EN4 area mainly in autumn and winter, mostly over large areas. Lesser black-backed gulls can be found all year round in the EN4 area, but they are most common in spring and winter. Terns occur mainly during migration periods. In recent investigations, 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 concentration area of loons in spring (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 to the northwest and east of EN4 (IBL UMWELTPLANUNG et al. 2017a, IBL Umweltplanung et al. 2018, IBL Umweltplanung et al. 2019).

The most frequently represented species are herring gulls, kittiwakes - especially in association with fishing activities -, petrels - independent of fishing activities, especially in autumn and winter in high densities - and aukes. The latter, mainly common guillemots and razorbills, occur only on average in the area around the EN4 site, compared to the offshore areas of the EEZ. The indirect surroundings of the EN4 area are partly used as a feeding ground in summer by breeding birds from the breeding colonies of Helgoland. Northern fulmar and Northern gannet occur rather sporadically (IBL Umweltplanung et al. 2016b, IBL Umwelt planung et al. 2017a, IBL Umweltplanung et al. 2018, IBL Umweltplanung et al. 2019).

Area EN5 (Zone 2)

The area surrounding EN5 has a high incidence of seabirds. All results so far show a gradient in the composition of the bird community: The area east of the EN5 area marks the transition between coastal areas with water depths below 20 m and areas with increasing water depth and distance to the coast. The vicinity of EN5 thus has a mixed bird community with a high proportion of shorebirds in nearshore areas; this transitions westwards into an upland bird community with increasing water depth (BioConsult SH 2015). In recent investigations, the black scoter was the most abundant species in the study area in the nearshore area east of area EN5 in both ship-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 such as kittiwake, *Larus* gulls and auks are increasingly dominant. To the west of Area EN5, the Northern fulmar also occurs in late winter and summer (IfAÖ 2016a, IfAÖ 2017). The Northern gannet occurs 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 listed in Annex I of the Birds Directive (V-RL) occur regularly. All subareas of area EN5 are located in the main concentration area of loons in the German Bight (BMU 2009) in spring. From March to mid-May (species-specific spring), high densities with marked intra- and interannual variability are recorded in the area around Area EN5 (Garthe et al. 2015, Garthe et al. 2018, BioConsult SH et al. 2020). According to current investigations, the occurrence of loons east of the EN5 area is concentrated within the wild bird conservation area to the south and north and south of the EN5 area. In the other seasons, divers are only occasionally observed (BioConsult SH 2017, IfAÖ 2017, BioConsult SH 2018, IfAÖ 2018, BioConsult SH 2019, IfAÖ 2019b, BioConsult SH 2020). Lesser black-backed gulls are mainly found during migration periods and in winter in low densities in the EN5 area. The 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)

The areas EN6 to EN13 north of the traffic separation areas show a medium to seasonal high occurrence of seabirds. The range of species and, above all, the abundance of species make these areas a typical habitat for the seabird community. The most common species are the guillemot, kittiwake, razorbill and lesser black-backed gull. Gulls are observed here mainly on the hunt for fishing waste. Gulls occur in small numbers in autumn and winter, independently of fishing activities. Northern fulmars and gannets are observed all year round in this area 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 around areas EN6 to EN13 during migration periods and in winter. The occurrence of little 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 Umwelt planung et al. 2018). Compared with the main concentration area, only low diver densities have been recorded in the adjacent areas in spring so far (IfAÖ 2016b).

Due to the depth of the water, the areas are of no importance as resting and feeding habitats for diving sea ducks that seek their food on the sea floor. Many of the exclusively fish-eating species of seabird found here seek their food by diving in the water column. These species are attracted by the concentrated presence of fish and macrozooplankton.

Due to their nature, areas EN6 to EN13 are part of the extensive habitat of the common guillemot in the North Sea. Guillemots can be found there in large numbers, especially in autumn and winter. Investigations 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). There is a case for this:

- the potential for resting and feeding habitat, which is extensive throughout the North Sea, based on its large-scale distribution in the EEZ,
- the high mobility also during the guidance of young birds and
- the repeatedly observed high spatial and temporal variability of the occurrence.

Areas EN14 to EN19 (Zones 4 + 5)

From Areas EN14 to EN19 in the “Duck’s Bill”, the seabird monitoring investigations conducted by the FTZ on behalf of the BfN provide information on the seabird community. This area is one of the typical habitats of seabird species. Northern fulmars and kittiwakes occur all year round, but especially in spring and winter. Razorbills and common guillemots are most abundant in winter, the latter also occurring in spring in this remote area of the EEZ. The Doggerbank area within the German EEZ belongs to the foothills of the range of the common 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 great amount of research carried out in recent years and the current state of knowledge allow a good assessment of the importance and status of individual sub-areas and areas as habitats for seabirds. This significance results from the assessments of the occurrence and spatial units or functions. In addition, the criteria of protection status and legacy impacts are considered at a higher level.

2.9.3.1 Protection status

Table 13 summarises the classification of the most common resting bird species in the EEZ into national and international threat categories.

Table 13: Assignment to the risk categories of the European Red List of the most important resting bird species of the German EEZ in the North Sea. Definition according to IUCN: LC = least concern; NT = near-threatened; VU = vulnerable, threatened; EN = endangered; CR = critically endangered (BirdLife International 2015a). Definition according to SPEC: SPEC 3 = not limited to Europe but with negative stock development and unfavourable conservation status. SPEC 1 = European species in need of global protective measures (i.e. classified as Critically Endangered, Endangered, Vulnerable, Near Threatened, or Data Deficient on a global scale(BirdLife International 2015b)

Common name (*scientific Name*)	**Appendix I V-RL[1]**	**Red List (Europe)[2]**	**Red List (EU27)[2]**	**SPEC[3]**
Red-throated diver *(Gavia stellata)*	X	LC	LC	3a
Black-throated diver *(Gavia artica)*	X	LC	LC	3a
Northern fulmar *(Fulmarus glacialis)*		EN	VU	3b
Northern gannet *(Morus bassanus)*		LC	LC	
Black scoter *(Melanitta nigra)*		VU	VU	
Great black-backed gull *(Larus marinus)*		LC	LC	
Lesser black-backed 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 name (*scientific Name*)	Appendix I V-RL[1]	Red List (Europe)[2]	Red List (EU27)[2]	SPEC[3]
Common tern *(Sterna hirundo)*	X	LC	LC	
Arctic tern *(Sterna paradisea)*	X	LC	LC	
Guillemot *(Uria aalge)*		NT	LC	3b
Razorbill *(Alca torda)*		NT	LC	1b

[1] Appendix 1 V-RL

[2] BirdLife International (2015a) European Red List of Birds

[3] BirdLife International (2015b) European Birds of Conservation Concern

[a] Wintering

[b] Breeding

2.9.3.2 Legacy impacts

As part of the marine ecosystem, seabirds are exposed to many legacy impacts 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 change***: Changes in water temperature are accompanied by changes in water circulation, plankton distribution and the composition of the fish fauna. Plankton and fish fauna serve as a food source for seabirds. However, because of the uncertainty regarding the effects of climate change on the individual ecosystem components, it is hardly possible to predict the impacts 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. Fisheries can lead to a reduction in the food supply and even to food limitation. Selective fishing of fish species or fish sizes may lead to changes in the food supply for seabirds. Fishing discards provide additional food sources for some seabird species. The resulting trend towards more birds (lesser black-backed gull, herring gull, common gull, and black-headed gull) has been established by targeted investigations (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 impacts on disturbance-sensitive species as shipping traffic. In addition, there is an increase in the volume of shipping, e.g. due to supply trips. There is also a risk of collision with such structures.

- ***Other legacy impacts:*** In addition, eutrophication, the accumulation of pollutants in marine food chains, and waste 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 stocks 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 regarded as natural for the reasons given here.

2.9.3.3 Significance of sub-area II of the nature conservation area "Sylter Außenriff – Östliche Deutsche Bucht"

Sub-area II of the "Sylt Outer Reef - Eastern German Bight" nature conservation area has an outstanding function in the German Bight as a feeding, wintering, moulting, transit and resting area for species listed in Annex I of the VRL (in particular red-throated diver, black-throated diver, little gull, Arctic, Caspian and Arctic tern) and regularly occurring migratory bird species (in particular the common and lesser black-backed gull, common fulmar, northern gannet, kittiwake, common guillemot and razorbill and common scoter).

The importance of individual parts of the nature conservation area for resting and migratory birds varies from year to year due to hydrographic conditions and weather patterns. Within the bird sanctuary, numerous migratory and resting birds use the high biomass available. In particular, the biomass of the mixed zone (roughly along the 20 m depth line) between estuarine and open waters represents a temporarily abundant food source.

2.9.3.4 Importance of the main concentration area for divers in the Deutsche Bucht

The main concentration area is a particularly important component of the marine environment with regard to seabirds and resting birds, especially the species group divers.

It is the most important resting place for loons in the German North Sea in spring. Every year, several thousand loons, mainly red-throated divers, visit the area for a stopover on their way to their 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 BMU position paper (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-RL, such as loons, terns and little gulls, use the area of areas EN1 to EN3 as a feeding ground only on average and predominantly during migration periods. They do not consider the surroundings of these areas to be valuable resting habitats or preferred staging posts 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.

Within the three areas, the abundance and distribution of seabirds show a high degree of interannual variability specific to the species, with small-scale variability occurring within the areas.

The most common species are ship followers, which benefit from fishing waste. Pre-pollution from shipping, fishing and offshore wind farms in the vicinity of areas EN1, EN2 and EN3 are of medium to sometimes 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 average importance of the areas for seabirds and resting birds is derived from the assessment of the protected status, occurrence, spatial unity and the existing impacts on seabird populations 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 conservation area “Sylter Außenriff – Östliche Deutsche Bucht” and in the southernmost area of the main concentration area of divers in spring in the Deutsche Bucht (BMU 2009). The surroundings of the EN4 area are therefore of great importance for loons, even if the densities are mostly below the densities recorded in the conservation area and in the areas northwest of the EN4 area.

The occurrence ofther species of birds listed in Annex I of the V-RL, such as terns and little gulls, is more or less average in the EN4 area. For the other seabird species to be conserved in the conservation area, the surroundings of the EN4 area are in part of high importance. The abundance and distribution of seabirds within the area show a high interannual variability. The area is of medium to highimportance as a feeding ground, depending on the species. The prior impacts of shipping, fishing and offshore wind farms in this area are of medium to seasonally high intensity for seabirds. For breeding birds of the breeding colonies on Helgoland and on the islands off the North Frisian coast, the EN4 area is of low to medium importance as a feeding ground due to its distance.

Area EN5 (Zone 2)

All findings to date indicate that the EN5 area is of high significance to seabirds.

For the red-throated and black-throated divers listed in Annex I of the V-RL, the surroundings of the EN5 area are of very high significance. All sub-areas are located in the main concentration area of loons in the German Bight (BMU 2009) in spring. To the east of the EN5 area is sub-area II of the "Sylt Outer Reef - Eastern German Bight" nature conservation area (Regulation of 27 September 2017, Federal Law Gazette Part I No. 63, 3423). A high incidence of other protected seabird species has also been recorded here, depending on the season and species. Other bird species listed in Annex I of the V-RL, such as terns and little gulls, also occur in the EN5 area.

The EN5 area and its surroundings are in the transitional area of distribution of many coastal bird species, including diving sea ducks, within the bird sanctuary, as well as an increasing number of seabird species to the west of the area. The abundance and distribution of bird species within the area shows a high degree of interannual variability. The area's surroundings are of medium, intermittent but also high significance as a feeding ground for many species of seabirds. For loons, the EN area is of high significance as a feeding ground before returning to their breeding grounds in spring.

For breeding birds, the EN5 area is of limited significance due to its distance from the coast and islands with breeding colonies as feeding grounds. Legacy impacts from 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 evidence to date indicates that the areas north of the traffic separation zones are of medium significance for seabirds. Overall, the areas have a medium seabird occurrence. The areas are most commonly used by seabird species that are widely distributed throughout the North Sea, including ship followers that benefit from by-catch.

Species that are sensitive to disturbance (e.g. divers) are present only in the areas for a short time (e.g. when foraging) and during the main migration periods. The areas are located outside the main distribution area of loons in spring. For other species of seabirds particularly worth of conservation (as listed in Annex I of the V-RL), the areas are also not considered valuable resting habitats or preferred staging posts in the German Bight. The abundance and distribution of seabirds within the areas show a high degree of interannual variability. The areas are of medium significance as feeding grounds for seabird species. Due to their distance from the coast, areas EN6 to EN13 are of no significance for breeding birds. The prior impacts of shipping and fishing in the areas are of medium to sometimes high intensity for seabirds. Due to the development of individual areas (EN6 and EN8) to date, the impact of offshore wind farms in the EN6 to EN13 areas can generally be regarded as low.

Areas EN14 to EN19 (Zones 4 + 5)

Areas EN14 to EN19 are typical habitats for seabird species such as fulmars, guillemots and kittiwakes. Due to their distance from the coast, it can be assumed that the areas are of no significance to breeding birds. The current data sources are not sufficiently updated to allow 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 investigations and monitoring programmes will focus more on this area of the EEZ and thus extend the data sources.

2.9.3.6 Conclusion

The North Sea EEZ can be subdivided into different sub-areas, each of which has a seabird population to be expected in view of the prevailing hydrographic conditions, distances from the coast, existing pollution and species-specific habitat requirements.

2.10 Migratory birds

Bird migration is usually defined as periodic migrations between the breeding area and a separate non-breeding area, which in the case of birds at higher latitudes normally contains the wintering grounds. Since bird migration takes place annually, it is also called annual migration - and is spread throughout the world. In this context, one also speaks of two-way migratory birds, which make a return journey, or annual migratory birds, which migrate every year. Often, in addition to a resting place, one or more stopovers are made, be it for moulting, to find favourable feeding grounds or for other reasons. A distinction is made between long-distance and short-distance migrants, depending on distance covered and on physiological criteria.

2.10.1 Data situation

Surveys on bird migration across the southeastern North Sea were already conducted on Helgoland in the 19th century (Gätke 1900). In particular for species for which habitat requirements are met by the trapping garden*, long-term observation series on migration phenology and species-specific changes are available (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).

Ecological accompanying 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 supplement basic work. Particularly noteworthy in this context are the bird migration surveys at FINO1, which were begun in 2003 and enable largely continuous radar measurements of bird migration in the offshore area under constant conditions. Extensive results were published in the framework of the BeoFINO (Orejas et al. 2005) and FINOBIRD reports (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 Deutsche Bucht (BALLASUS 2007).

2.10.1.1 Spatial distribution and temporal variability of migratory birds

According to current knowledge, migratory bird activity can roughly be divided into two phenomena: broad-fronted 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 according to the current state of knowledge. Species migrating at night in particular, which cannot be guided by geographical structures because of the 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 actual course of migration is determined mainly by weather conditions. Weather factors also influence at what altitude and at what speed the animals 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 terms of energy. As a result, bird migration is concentrated on individual days or nights in autumn and 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).

The broad-fronted migration is typical for the night migration of songbirds, but also for the day migration of songbirds. A current cross-project evaluation of all data from large-scale bird migration monitoring for offshore wind farm projects showed a 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). For several 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 the limni* migration towards the offshore area (DAVIDSE et al. 2000; LEOPOLD et al. 2004; HÜPPOP et al. 2006). Also the comparative investigations of the visible diurnal migration of waders and waterbirds between Helgoland and the (former) Research Platform North Sea (FPN), 72 km west of Sylt by DIERSCHKE (2001) indicate a gradient between the coast and the open North Sea. This assumption is confirmed in the BeoFINO final report, as the results of the visual observations presented show a clear concentration of waterfowl near the coast. Only a few bird species are found in the offshore area in equal or larger numbers of individuals (e.g. red-throated diver, pink-footed goose).

However, reliable information on the magnitude of the decrease is not possible due to the methodological requirements. Uncertainties of the visual observations result, e.g., from lack of knowledge about the proportion of trains at higher altitudes. Furthermore, species such as red-throated diver or pink-footed goose also stand out among water birds, which are observed at Helgoland with the same or higher numbers of individuals than from Sylt or Wangerooge (HÜPPOP et al. 2005, 2006). Table

14 illustrates exclusively the differences in visible migration summed over all species for Helgoland, Sylt, and Wangerooge according to HÜPPOP et al. (2009). The intensity of bird migration on Helgoland is less reduced in autumn than in spring. A certain contribution to relatively high intensities of Wangerooge and Sylt by local resting birds cannot be ruled out. It should also be noted that the difference for songbirds is probably be much smaller if night migration is taken into account.

Table 14: Mean migration intensity (Ind/h) over sea in the first three hours after sunrise for all species together at the three sites Wangerooge, Helgoland, and Sylt for spring and autumn (HÜPPOP et al. 2009).

Seawatching	Spring	Autumn
Wangerooge	598,4	305,9
Helgoland	144,3	168,8
Sylt	507,2	554,2

Although the migratory intensity of selected species and species groups decreases with distance from the coast, overall there is broad frontal movement across the open sea. The special position of pronounced nocturnal migratory birds should again be noted, for which there is as yet little knowledge of decreasing migratory intensity with increasing distance from the coast. At least, far fewer nocturnal migrators are recorded by radar on FINO1 than on Helgoland (HÜPPOP et al. 2009). Finally, the numbers of individuals documented on single 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 document mass migration far from the coast and speak against pronounced gradients in migratory 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 is documented all year round using various methods (radar, seawatching, migratory call recording), with strong seasonal fluctuations, with the main focus on 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 Deutsche Bucht at tens to hundreds of millions. The largest proportion is made up of songbirds, the majority of which cross the North Sea at night (HÜPPOP et al. 2005, 2006). The majority of birds come from Norway, Sweden and Denmark. For waterfowl and waders, however, breeding grounds extend far northeast into the Palaearctic and in the north and northwest to Spitsbergen, Iceland and Greenland.

Estimates of the annual migration volume over the North Sea by BUREAU WAARDENBURG (1999) for a wider range 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 across the North Sea.

The German Bight is on the migration route of numerous bird species. For example, 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) should 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).

Nocturnal 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 night-time observations from the former North Sea Research Platform and the island of Helgoland confirm that night-time bird migration during the main migration periods is concentrated on nights with favourable migratory conditions and then becomes a mass migration. In spring, more than 50% of the migration detectable by radar 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 observed from December to February and from June to August.

The migration intensity follows a distinct daily rhythm. Results of the automatic migration bird-call recording on FINO1 show an increasing migration activity in the evening and night hours, reaching 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 recorded in the first hours of the morning and then ebbed away towards midday (HILL & HILL 2010, AVITEC RESEARCH GBR 2015). This rhythm can vary according to location and season.

Figure 36 shows a detailed section of the broad front over the south-eastern North Sea. It should be emphasised that the distances between the lines of individual migration flows merely indicate the direction of a gradient. Therefore, conclusions about the magnitude of spatial trends must not be drawn from Figure 36 under any circumstances. The thickness of the lines also only qualitatively illustrates intensity differences between the migration streams.

The seasonal north-east-south-west or south-west-north-east migration dominates over a wide area according to the current state of knowledge (see Figure 37), although there may be some 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 to the south-southwest in autumn (departure) during their investigations using radar on the FINO1 research platform (cf Figure 37). However, the results only reflect the conditions in good weather. In spring, a clear direction (northeast) was also discernible, but only at night when no foraging birds were active.

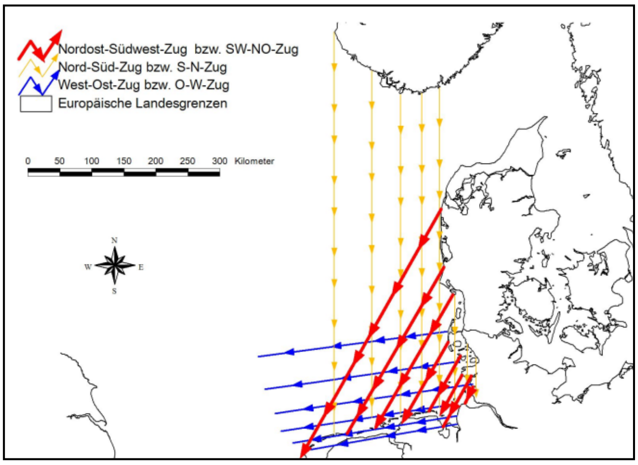


Figure 36: Scheme of main migration routes across the southeastern North Sea (shown for autumn from HÜPPOP et al. 2005a).

Radar recordings at the EIS sites also confirm this main migration direction, but there are indications of certain variations in the migration direction per location. In areas far north of the coast (Area 5), larger numbers of south-facing migratory birds were observed in autumn and north-facing in spring. However, the EIS observations were carried out in small time windows. Further statements on spatial differences in the proportion of migration directions that deviate from the main northeast-southwest direction of migration are therefore not possible at present (HÜPPOP et al. 2005a).

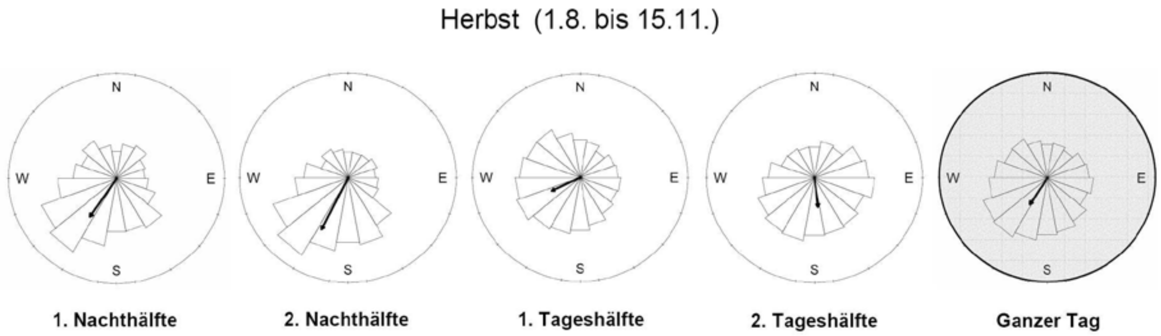


Figure 37: Relative proportions of the flight directions determined for the FINO1 research platform in autumn, for four times of the day and for the whole day (grey) averaged over the years 2005 to 2007. The sum of the individual directional shares within a circle graph is 100% in each case. The direction of the arrow in the centre of the circle indicates the mean direction of flight; the length of the arrow is a measure of its uniqueness (HÜPPOP et al. 2009).

The flight altitude distribution differs between the light and dark phases. In the dark phase, the flight or train takes 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 their behaviour. As a rule, relatively high-flying migratory bird species occur primarily at night, while other, usually lower-flying species (such as seabirds or gulls) stop flying at night and rest on the water or on land.

Most of the signals on FINO1 were registered at all seasons up to a height of 100 m. In summer, the high level of flight activity in this area was mainly due to food-seeking individuals. The radar recordings at the "alpha ventus" test site also show a more intensive use of the height classes below 200 m. In spring 2009, 39% of the echoes were surveyed 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 recorded in the upper altitude classes. EASTWOOD & RIDER (1965) and JELLMANN (1989) also found greater 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 migratory activity (JELLMANN 1979). However, the distribution of migration altitudes can differ greatly between individual nights and is strongly influenced by the current weather situation (JELLMANN 1979, HÜPPOP et al. 2006).

2.10.1.3 Species composition

During the course of the year and during migratory phases, the flight or migratory activity of the light phase is mostly dominated by species groups that use the area both as a resting and transit area. Among these, the seagulls, terns and seabirds with the species/grouping of herring gulls, kittiwakes, petrels, sandwich gulls, sandwich terns, common and Arctic terns and gannets reach the highest dominance values and/or continuity. Among the migratory bird species that cross the sea area exclusively, the majority of the records concern songbirds.

While songbirds are quite concentrated and relatively directed in the main migration months, seagulls are present almost all year round. This is often associated with fishing vessels or other vessels.

In some cases, large populations of songbirds dominate migration. 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 from songbirds, especially thrushes. Meadow pipit, robin, chaffinch, winter goldcrest and skylark were also frequently represented in addition to the starling. The second most common group of species was the group of terns (mainly sandwich tern) with 11%. Within the framework of the migratory call surveys for "alpha ventus", thrushes also formed the majority of the registered migratory calls* (HILL & HILL 2010).

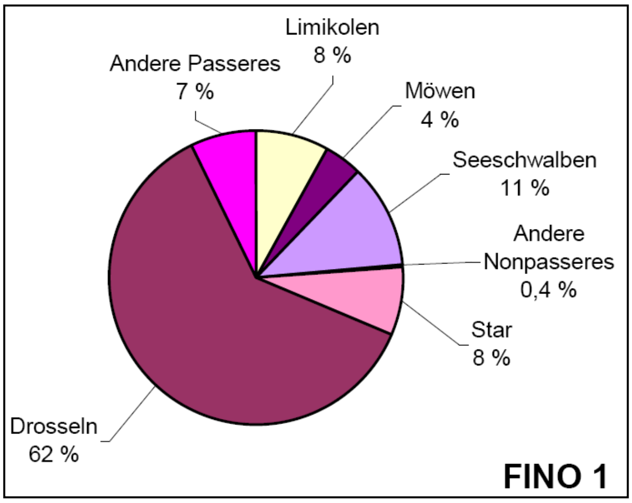


Figure 38: Proportions of species groups in all call surveys near the FINO1 research platform from to 12 March 2004 to 1 June 2007 (HÜPPOP et al. 2012).

2.10.2 Status assessment of the protected asset migratory birds

The status assessment of migratory birds in the German North Sea EEZ is assessed on the basis of the following assessment criteria:

Large-scale importance of bird migration

Evaluation of occurrence

Rarity and threat

Legacy impacts

2.10.2.1 Large-scale importance

According to current knowledge, several 10 - 100 million (max. 152 million) birds migrate across the German Bight every year. Singing birds make up the largest proportion, the majority of which cross the North Sea at night and in broad-fronted 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 are from Norway, Sweden and Denmark. For songbirds migrating primarily during the day, there are also indications of a decrease with distance from the coast, as Helgoland has in the past recorded significantly lower migration intensity than Sylt (Hüppop et al. 2005). This trend is also confirmed for the limbicolous range by radar surveys (Hüppop et al. 2006). The same seems to apply to waterbird and wading bird migration (Dierschke 2001).

The definition of areas of concentration and guidelines for bird migration cannot be seen in a small scale in the offshore sector due to the lack of structures. An assessment of this criterion must take into account the large-scale nature 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 can be assumed that considerable numbers of the songbirds breeding in Northern Europe migrate across the North Sea.

A characteristic feature of nocturnal bird migration is the strong seasonal fluctuations in migration intensity, with most of the migration taking place in just a few nights. In addition to the research projects BeoFINO and FINOBIRD mentioned above, this correlation is also regularly demonstrated in environmental impact studies on offshore wind farms and in construction and operation-related monitoring.

2.10.2.3 Rarity and threat

The species spectrum of the 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 annexes on the conservation status of birds in Central Europe:

- Annex I of the V-RL,
- 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),
- SPEC (Species of European Conservation Concern).

SPEC classifies the bird species according to Europe's share of the population and the level of risk posed by BirdLife International.

Of the species detected, 20 are listed in Annex I of the V-RL: red-throated and black-throated diver, Sandwich tern, common tern, Arctic tern, little tern and black tern, white-thighed swallow, short-eared owl, Eurasian marsh harrier, hen harrier, osprey and merlin, little gull, European golden plover, ruff, wood sandpiper and bar-tailed godwit, barnacle goose, wood lark, and bluethroat.

The species spectrum of over 200 migrating across the North Sea each year can be described as average in comparison to the 425 migratory bird species that have been recorded on Helgoland over the years. However, a very high proportion have an international conservation status and are endangered throughout Germany. For these reasons, the North Sea EEZ is of average to above-average significance in terms of species numbers and endangered status for bird migration.

2.10.2.4 Legacy impacts

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

Major anthropogenic factors that increase mortality of migratory birds are active hunting, collisions with anthropogenic structures and, for waterbirds and seabirds, pollution by oil or chemicals (CAMPHUYSEN et al. 1999). The various factors have a cumulative effect; the detached significance is therefore usually difficult to determine. Especially in Mediterranean countries, a statistically insufficient amount of hunting still takes place (HÜPPOP & HÜPPOP 2002). TUCKER & HEATH (1994) conclude that more than 30% of European species marked by population declines are also threatened by hunting.

The proportion of birds ringed on Helgoland and indirectly killed by humans has increased in the past in all species groups and finding regions; landings on buildings and vehicles were the main causes (HÜPPOP & HÜPPOP 2002). Surveys of collision victims at four lighthouses in the German Bight show that songbirds are strongly dominant. Starlings, thrushes (song thrush, red thrush, juniper thrush) and blackbirds are particularly prominent among the birds being found 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). During 36 of 159 visits to the research platform FINO1 with bird monitoring between October 2003 and December 2007, a total of 770 dead birds (35 species) were found. Thrushes and starlings were the most common, accounting for 85% of the total. The species concerned are characterised by nocturnal migration and relatively large populations. It is striking that almost 50% of the collisions registered on FINO1 occurred in only two nights. On both nights, there were south-eastern winds (which may have promoted migration by sea) and poor visibility (which may have led to a reduction in flight height and increased attraction by the illuminated platform) (HÜPPOP et al. 2009). The area around area N-3.7 is already partly covered with wind farms.

Global warming and climate change also have measurable impacts on bird migration (e.g. through changes in phenology or altered arrival and departure times). However, these are species-specific and vary from region to region (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 conditions in breeding, resting and wintering areas or the ressources of these sub-habitats.

The legacy impacts are rated as medium to temporarily high overall.

2.10.2.5 Importance of areas and sites for migratory birds

The areas EN1 to EN13 for offshore wind energy utilisation in the North Sea, as defined in the spatial plan, will be assessed separately with regard to their significance for bird migration. Due to a lack of information on bird migration in the areas EN14 to EN19 in the Duck's Bill of the EEZ, these areas are not assessed separately.

In analogy to the assessment of the status of birds in the EEZ, the significance of areas EN1 to EN13 for bird migration is assessed using the following evaluation criteria:

Large-scale importance of bird migration

Evaluation of occurrence

Rarity and threat

For the criterion of legacy impacts, please refer to the explanations in Chapter 2.10.2.4.

Large-scale importance

Special migratory corridors are not recognisable for any migratory bird species in the North Sea EEZ area. Bird migration takes place in an unspecified broad-fronted 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 significance for bird migration.

Assessment of the occurrence

In the maritime region, where areas **EN1 to EN3** are located, echoes were almost consistently detected on the basis of entire migration nights or days during the cluster investigations “North of Borkum” (AVITEC RESEARCH 2017) in 2016 in both migration periods. The main bird migration events were in spring at the end of March and April and in autumn in October and early November. This resulted in bird migration events of varying strength up to mass migration on a long-term site-specific scale. Projected for the entire spring season, 142,764.6 bird movements and 121 echoes/(h*km) were recorded during the day as well as 265,039 bird movements and 358 echoes/(h*km) at night. In autumn, the corresponding values were extrapolated to 127,648 bird movements; 129 echoes/(h*km) during the day and at night extrapolated to 203,236 bird movements; 217 echoes /(h*km). 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 investigations “Nördlich Helgoland” (IBL ET AL. 2017) in the area of Area **EN4** , the monthly means of nocturnal migration rates ranged from 34 echoes/(h*km) in August 2016 to 423 echoes/(h*km) in March 2016. The average migration rate over the whole period was 224 echos/(h*km). The highest nocturnal migration rate was reached in the night from 26 to 27 October 2016 (3,311 echos/(h*km)). In about 39% (spring) and 67% (autumn) of the nights the migration rates were below 100 echoes/(h*km). The daytime migration rates were significantly lower, ranging from 38 echoes/(h*km) in August 2016 to 142 echoes/(h*km) in March 2016. The mean migration rate over the whole period was 93 echoes/(h*km). In total, nine nights with migration rates of more than 1,000 echos/(h*km) occurred within the 2016 reporting year (eight in spring, one in autumn). This means that the maximum migratory rates are of a similar order of magnitude as on FINO1 (cluster "North of Borkum").

Measurements taken as part of the cluster monitoring “Westlich Sylt” (BIOCONSULT SH 2017), which also cover Area **EN5**, show that according to the results of the vertical radar, nocturnal migration is generally more pronounced than diurnal migration. During autumn migration in 2016, intensive bird migration was recorded primarily in October and November, while the months of July and August had, as expected, 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 during 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. During the five nights with the highest migratory intensity 72.5% of the total number of spring migration and 52.4% of autumn migration were recorded. High migration rates were achieved on only a few days with low bird migration on most survey days.

The investigations of the cluster monitoring “Cluster 6” from 2015 (Planungsgruppe Umweltplanungen 2017) as well as studies of the cluster monitoring “East of Austerngrund” (IFAÖ et al. 2017) from 2016 cover areas **EN6** to **8** and are used for the assessment. Current data for the areas of **EN9** to **13 are** missing, but as these directly border the areas 6-8 in the north, the following explanations are transferable.

During the Cluster 6 investigations, nocturnal bird migration showed strong fluctuations over the course of the survey period (January 2015 to March 2016) with strong bird migration occurring on only one night with mean migration rates of more than 1,000 echoes/(h*km) (18/19 October 2015). In spring, maximum mean migration rates of about 700 echoes/(h*km) were recorded. In about 25 % of the nights, the migration rate was below 10 echoes/(h*km), and in about 52% of the nights, it was below 50 echoes/(h*km). 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 the mean values and median within the monthly values indicates a high variance of migration rates, especially in April and October months in 2015. The seasonal distribution and intensity of the daytime migration rates as per 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 October 2015). The nocturnal migration rates determined by vertical radar in the cluster studies "East of Oyster Ground" showed a high variation between the individual nights. Monthly averages of nocturnal migration rates ranged from

29 echoes/(h*km) (May 2016) to 361 echoes/(h*km) in October 2016, averaging 144 echoes/(h*km) over the entire period. Daytime migration rates were lower (mean value: 84 echoes/(h*km)) and ranged from 27 echoes/(h*km) in April 2016 to 125 echoes/(h*km) in October 2016. The mean nocturnal migration rates were higher in spring (162 echos/(h*km)) than in autumn (131 echos/(h*km)), but the difference was not statistically significant. In contrast, the daytime migration rates differed significantly between migration periods with higher migration rates in autumn (105 echos/(h*km). There were days with stronger migration than in spring (54 echos/(h*km) especially in August and October 2016.

An approximate comparison of the above described results of migration intensities for individual areas gives roughly comparable results for all areas (**EN1-13**) with regard to the monthly averages. Differences can be seen in the maximum values. However, it must be taken into account that there is a large interannual variability.

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 2019a).

Taking into account the high rate of migration over the German Bight, the individual areas **EN1** to **EN13 are of** medium significance with regard to the criterion of migration intensity.

Number of species and threat 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 studies for 2015 and 2016, between 68 and 81 species were identified in the sea areas each year. Of the species identified, 7-13 species are listed in Annex I of the V-RL. The species numbers identified are rated as average and the endangerment status as above average.

Conclusion

Although guidelines and areas of concentration are missing, the areas **EN1** to **EN13** have an average to above-average significance for bird migration overall.

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 resting sites and hibernation areas are several hundred kilometres apart. Migratory movements of bats in search of extensive food sources and suitable resting places are often observed on land but mainly aperiodically. However, migratory movements of bats over the North Sea are still poorly documented and largely unexplored.

2.11.1 Data situation

Data sources on bat migration over the North Sea are 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 recordings on Helgoland as well as acoustic recordings on the research platform FINO1 and other sources of knowledge in order to reflect the current state of knowledge.

2.11.2 Spatial distribution and status assessment

Both the sedentary and migratory behaviour of bats is highly variable. On the one hand, differences can occur depending on species and sex. On the other hand, sedentary or migratory movements can vary greatly even within the populations of a species. Based on their sedentary behaviour, bats are divided into short-distance, medium-distance and long-distance migratory species.

Bats go on short- and medium-distance migrations in search of nesting, feeding, and resting places. Corridors along flowing waters, around lakes and Bodden waters are known for medium distances (BACH & MEYER-CORDS 2005). However, long-distance migrations are still largely unexplored. Bats migratory routes are scarcely described. This particularly applies to migratory movements across the open sea. In contrast to bird migration, which has been confirmed 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 mountain noctule bat (*Nyctalus noctula*), Nathusius's pipistrelle (*Pipistrellus nathusii*), parti-coloured bat (*Verspertilia murinus*), and Leisler's bat (*Nyctalus leisleri*). For these four species, migrations over a distance of 1,500 to 2,000 km are regularly recorded (TRESS et al. 2004, HUTTERER et al. 2005).

Long-distance migratory movements are 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 encountered 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 south-west Jutland to the North Sea leads to the same conclusion (SKIBA 2011).

Visual observations such as 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 nocturnally migrating bats over the sea. The recording of ultrasonic calls of bats by suitable detectors (bat detectors) provides good results on land about the occurrence and migration movements of bats (SKIBA 2003). The results obtained so far from the use of bat detectors in the North Sea only provide initial indications. Acoustic surveys of bat migration over the North Sea on the FINO1 research platform 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, the general occurrence, species composition and migration routes as well as the heights at which bats migrate must be considered in order to assess the potential risk of collision with offshore wind farms. Depending on location and method, the individuals surveyed by HÜPPOP & HILL (2016) were surveyed between 15 and 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. BRABANT et al. (2018) investigated bat occurrence at Thornton Bank wind farm using bat detectors at 17 m and 94 m above ground. Only 10% of the 98 bat images were recorded at higher altitudes, i.e. significantly fewer than at 17 m..

As per Annex IV of the Habitats Directive, all bat species are among the animal and plant species of Community interest that require strict protection. Some species such as the Nathusius's pipistrelle and the mountain noctule bat are listed in Appendix II of the 1979 Convention on Migratory Species (CMS), "Bonn Convention". 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 "indeterminate", four species to the category "endangered", and three species to the category "critically endangered". The common bent-wing bat (*Miniopterus schreibersii)* is considered "extinct or lost". Of the species that have so far been recorded more frequently in marine or coastal areas of Germany, the noctule is on the early warning list, while the common pipistrelle and the Nathusius' pipistrelle are considered "safe". For an assessment of the endangerment status of the common swift data availability is considered insufficient.

The data available for the EEZ of the North Sea are fragmentary and insufficient to be able to draw conclusions about bat migration. It is not possible to draw concrete conclusions on migratory species, migration directions, migration heights, migration corridors and possible concentration ranges on the basis of the available data. What we have seen so far only confirms that bats, especially long-distance migratory species, fly over the North Sea.

2.12 Biological diversity

Biological diversity (or biodiversity for short) comprises the diversity of habitats and biotic communities, the diversity of species, and the genetic diversity within species (Section 2 Convention on Biological Diversity, 1992). Biodiversity is in the public eye. Species diversity is the result of an evolutionary process that has been going on for over 3.5 billion years, a dynamic process of extinction and species formation. Of the approximately 1.7 million species described by science to date, some 250,000 occur in the sea, and although there are considerably more species on land than in the sea, the sea is more comprehensive and phylogenetically more highly developed than the land in terms of its tribal biodiversity. Of the 33 known animal phyla, 32 are found in the sea; 15 of these are exclusively marine. (VON WESTERNHAGEN & DETHLEFSEN 2003).

Marine diversity cannot be directly observed and is therefore difficult to assess. For their assessment, tools such as nets, weirs, grabs, traps or optical registration methods must be used. However, the use of such devices can only ever provide a section of the actual species spectrum – precisely that which is specific to the device question. Since the North Sea, as a relatively shallow marginal sea, is more easily accessible than, for example, the deep sea, intensive marine and fisheries research has been carried out for about 150 years, which has led to an increase in knowledge about its flora and fauna. This makes it possible to refer to inventory lists and species catalogues in order 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) have been identified in the North Sea. About 1,500 marine species of macrozoobenthos 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 species of fish and lamprey. For the German North Sea, 189 species are reported (FRICKE et al. 1995). In the North Sea EEZ, 19 species of seabirds and resting birds regularly occur in larger stocks. Three of these 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 is countless evidence of changes in biodiversity and species assemblages at all systematic and trophic levels in 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 monitoring and warning function in this context because they show the status of the populations of species and biotopes in a region. Based on the Red Lists, it can be stated 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 vulnerable, whereby the bottlenose dolphin has even disappeared from the area of the German North Sea (VON NORDHEIM et al. 2003). Of the 19 regularly occurring sea and resting bird species, three species are listed in Annex I of the V-RL. In general, in accordance with the Birds Directive, all wild native bird species are to be conserved and thus protected.

2.13 Air

Shipping causes emissions of nitrogen oxides, sulphur dioxides, carbon dioxide and soot particles. These can negatively affect air quality and to a large extent are carried into the sea as atmospheric deposition. Since 1 January 2015, shipping in the North Sea has been subject to stricter rules as an emission control area, the so-called Sulphur Emission Control Area (SECA). Under Annex VI, Regulation 14 of MARPOL, ships may only use heavy fuel oil with a maximum sulphur content of 0.1%. Worldwide, a limit of 3.5% is currently still in force. According to a decision of the International Maritime Organisation (IMO) in 2016, this limit is to be reduced worldwide to 0.5% from 2020.

Emissions of nitrogen oxides are particularly relevant for the North Sea as an additional nutrient load. In 2017 the IMO has therefore decided that the North Sea will be declared a "Nitrogen Emission Control Area" (NECA) from 2021. The total reduction of 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 (European Monitoring and Evaluation Programme (EMEP 2016)).

2.14 Climate

The German North Sea is located in the temperate climate zone. An important influencing factor is warm Atlantic water from the North Atlantic Current. Icing can occur in coastal areas, but is rare and only occurs at intervals of several years.

There is broad 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 are sensitive to climate change.

Global warming is also expected to have a significant impact 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 have increasingly spread, and the habits of long-established species have changed, sometimes considerably.

2.15 Landscape

The marine landscape visible today above the water column is characterised by extensive 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 utilisation, and the necessary lighting can also have a negative impact on the appearance of the landscape.

In addition to offshore wind farms, the area under review also includes platforms and measuring masts for research purposes, 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 extent to which the landscape is impaired by vertical structures depends strongly on the 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).

In the case of platforms and offshore wind farms planned at a distance of at least 30 km from the coastline, the impairment of the landscape as perceived from land is not very high. At such a distance the platforms and wind farms will not be massively visible even in good visibility conditions. This also applies with regard to night-time safety lighting.

2.16 Cultural and other material resources (underwater cultural heritage)

2.16.1 Survey 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 territorial waters 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 exclusively responsible for state waters. Therefore, systematic processing of information on underwater cultural heritage in the EEZ has largely been omitted. The quality of the data also varies, for example from identified historical wrecks to location-precise indications from records, and may need to be improved for a concrete planning statement. The registers of sites and monuments therefore reflect the current state of knowledge, but not the actual stock of underwater cultural heritage.

Active recording of underwater obstacles – and thus also shipwrecks – in the North German territorial waters is carried out only by the Federal Maritime and Hydrographic Agency (BSH). However, this wreck search is not focused on underwater cultural heritage but rather serves to locate and assess obstacles to shipping and therefore concentrates on objects rising from the seabed that could pose a threat to maritime navigation or fishing. Although the findings of the BSH are regularly included in the registers of sites and monuments of the coastal states, underwater cultural heritage that is covered by sediment or barely visible on the seabed is not normally surveyed during wreck searches.

An impression of the actual density of soil monuments in the territorial waters is provided by maritime construction projects such as submarine cable connections or pipelines over the course of which a large number of previously unknown seabed monuments would regularly come to light during site investigations.

The risk of unexpected discovery of seabed monuments in the course of a construction project can be minimised only by a qualified inventory as part of the environmental impact assessment.

2.16.2 Potential for prehistoric settlement remains in the German EEZ

In the early Holocene, areas of the German EEZ in the North Sea were also landlocked regions which were settled by humans between 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). As a result, water depths of between 15 m and 50 m in the German North Sea EEZ are expected to yield preserved prehistoric settlement traces in paleosol landscapes. Landscape reconstructions can be used to identify special potential areas for archaeological sites. By evaluating erosion zones, areas with traces of occupation that are no longer preserved can be highlighted.

Figure 39: 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 a specialist article on the cultural heritage of the heritage protection authorities of the coastal states of Lower Saxony, Schleswig-Holstein and Mecklenburg-Western Pomerania)

An example of an area with high potential for the preservation of Stone Age settlement sites is the Ems Glacial Valley. Using drill cores and reflection seismics, the bedrock of the North Sea basin was reconstructed and the glacial valley of the Ems, which flows into the Elbe glacial stream, was traced (HEPP et al. 2017, HEPP et al. 2019). In the Mesolithic period, river valleys formed important settlement areas for the population oriented towards hunting and fishing. Of particular importance is the finding that the primeval river Ems changed from fresh to brackish water over the course of 200 years, which corresponds to a rapid sea-level rise of around 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 a closed find context at the bottom of the North Sea have been preserved here.

With a total area of 18,700 km² , the Doggerbank 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, Dogger Bank is on average only 30 m deep. On the basis of individual finds, settlement from Doggerland in the area of the Doggerbank can be proven from the early Mesolithic onwards (BALLIN, 2017)BAILEY et al. 2020, 190 ff.). A special potential for the conservation of archaeological sites is given by a natural event that took place when Doggerbank was still terrestrial and settled: Settlements may have been preserved as a closed find context under a massive sedimentary layer 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 vessels and wreckage

This type of underwater cultural heritage includes not only wrecks of watercraft but also wreckage and associated equipment, cargo and inventories. The majority of known wreck sites are made up of boats and vessels of various periods. The spectrum ranges from Stone Age dugouts to wooden trading vessels from the Middle Ages and warships from the World Wars.

Seaworthy vessels have been documented archaeologically for the North Sea area from the Bronze Age onwards. These include several boats from Great Britain, of which the Dover boat from around 1575-1520 BC is probably the best known (Clark 2004).

From the Middle Ages onwards, the sea routes of long-distance traders ran across the open sea, as the 12th chapter of the Hanseatic Sea Book in the "Hausmeer" (home 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, new finds in the open sea are increasingly being added. For example, during the salvage of containers in the North Sea in 2019, a merchant ship from 1536 with a cargo of copper bars 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 the coast of Rügen in 1718, and the Danish Orlog ship "Lindormen" of 1644 (Auer 2004; Auer 2010; Segschneider 2014).

Over the course of the 18th and 19th centuries, enormous increases in the volume of trade across the North and Baltic Sea was recorded. Examples include coal exports from the British Isles and timber exports from the Baltic States. These goods were transported on wooden sailing ships and later on iron steamships. Lively maritime trade also led to an increase in shipping accidents during this period. Ship finds from this period brought to light through archaeological investigation include the wreck of the British merchant ship "General Carleton" from 1785 (Ossowski, 2008) as well as the wreck of a 19th century coal transporter off Rotterdam (Adams et al., 1990).

With the emergence of industrial composite aircraft wreckage and iron or steel shipbuilding from the mid-19th century onwards, the knowledge gained from written and pictorial sources predominates. Because of their often better conservation, 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 because of the progressive corrosion of steel wrecks.

Because of their historical significance and, in some cases, the 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 sometimes resulted in the loss of several vessels within a limited space. In August 1914, for example, three small cruisers and a torpedo boat were sunk in a naval battle between the Imperial German Navy and the Royal Navy west of Heligoland. For example, three small cruisers and a torpedo boat sank in a naval battle between the Imperial German and British navy west of Helgoland in August 1914; the wrecks of these are all located in the German EEZ (Huber & Witt 2018).

Equipment or parts of cargo may provide evidence of maritime activities in the past. Among the most common objects are anchors that, for various reasons, were not recovered after an anchoring manoeuvre and remained on the seabed.

Ballast piles, accumulations of stone ballast on the bottom, formed, for example, when ships were loaded off a natural harbour, can also be an indication of the lightening of a vehicle 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 finds of aircraft wrecks in the North and Baltic Seas are related to World War II. 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 emergency ditching can lead to relatively well-preserved aircraft wrecks, crash sites are often marked by extensive debris fields at the seabed. In addition to providing insights into technical aspects of construction and use, the aircraft wrecks of World War 2 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.

2.16.5 Potential for wrecks in the German EEZ

Although the prehistoric and early historic wreck finds were mostly discovered in coastal waters or come from burial sites, such finds could also be present in the German EEZ under favourable conditions. Medieval shipwrecks at the latest are known from the high Baltic Sea at depths of over -50 m. There, the wooden wrecks are particularly well preserved thanks to the low temperatures and low levels of infestation by wood-decomposing organisms.

In general, wooden ships or remains thereof 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, like “time capsules”, allow unique insights into the past.

2.16.6 Status assessment of the protected asset underwater cultural heritage

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 asset 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. sea grave)
- Rarity value
- Integrity (degree of conservation, condition, threat)

The testimonial value varies depending on the conservation and type of site. For example, the historical testimonial value of underwater sites is generally very high because of the excellent 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, for example, to personal equipment, cargo, or armament. Well-preserved wrecks with preservation of inventory and construction elements have a high testimonial value*.

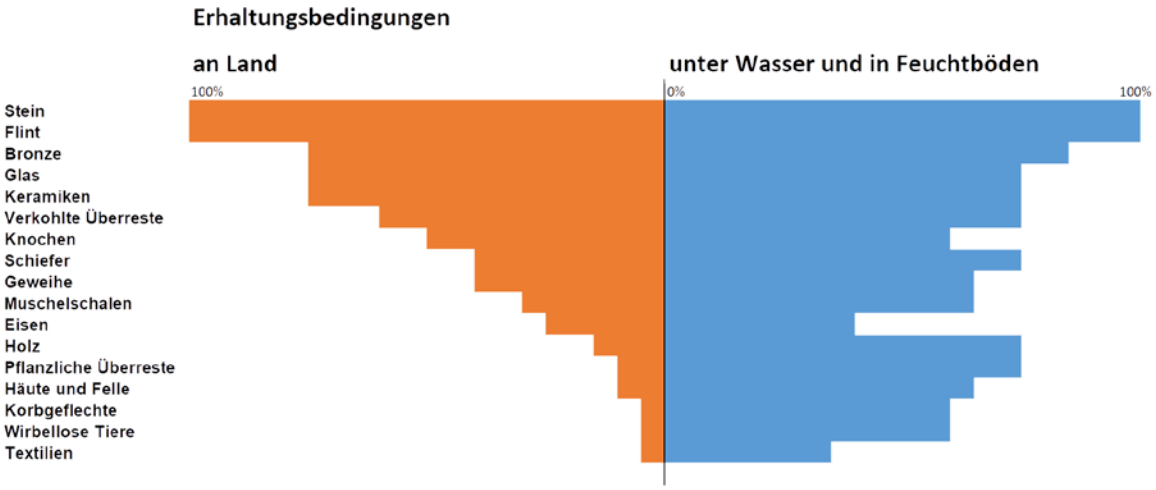


Figure 40: Comparison of the preservation conditions of archaeological finds on land and under water (according to Coles 1988).

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. They also had a representative function. The scientific, technical, and testimonial value of shipwrecks with well-preserved structural elements is therefore high.

Because 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 wreckage provides detailed insights into everyday life on board. Therefore, in addition to technological progress, conclusions about political, economic, and landscape-typical factors as well as the social structure of a society can often be drawn from ship finds. This illustrates the extraordinary research value of underwater sites and also their special integrity compared with 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 in good condition. Modern wreck finds can also have a high rarity value if they are characterised by special technical or construction features.

The integrity or conservation status 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 deposits of a wreck and later damage (e.g. by abiotic factors such as erosion by currents or decomposition by organisms) influence the integrity and preservation of a site or of portions 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 conservation conditions.

2.17 Human beings, including health

Overall, the area under review for which the spatial plan makes rules is of little significance for the protected asset human being.

On the one hand, the marine environment provides the working environment for people employed on ships and fixed installations at sea, in maritime shipping, fisheries, offshore wind industry, extraction of raw materials, scientific research and defence.

Precise figures on the number of people regularly staying in the area are not available.

Its importance as a working environment can be considered as rather low. Occupational health and safety is subject to the relevant specialist legislation, for shipping e.g. international maritime law and 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 area for people who use the sea space, on ferries and cruise ships, but also with sports boats and tourist vessels.

Direct use for recreation and leisure by pleasure boats and tourist vessels is seldom found in the North Sea.

Further impacts on humans or their living environment from activities at sea, e.g. as a result of shipwrecks, can occur beyond the area under review, especially on islands and along the coasts.

As the North Sea EEZ as a whole is of little importance for active recreational use and as a working environment, the prior pollution levels can be considered low. A special significance of the area under review for human health and wellbeing cannot be derived.

2.18 Interactions between the factors

The components of the marine ecosystem, from bacteria and plankton to marine mammals and birds, influence each other through complex processes. The protected biological resources plankton, benthos, fish, marine mammals, and birds, which are described individually in Chapter 2, are interdependent within the marine food chains.

The phytoplankton serves as a food source for the 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 have a central role in the marine ecosystem as primary consumers of phytoplankton on one hand and as the lowest secondary producer within the marine food chains on the other. Zooplankton serves as food for the secondary consumers of the marine food chains, from carnivorous zooplankton species to benthos, fish, marine mammals and seabirds. Among the top components of marine food chains are the predators. The upper predators within the marine food chains include water and sea birds and marine mammals. In the 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. Exhaustion of the producer results in the decline of the consumer. Consumers, in turn, control the growth of producers by eating away*. Food limitation affects the individual level by adversely affecting the condition of the individual. At the population level, food restriction leads to changes in the abundance and distribution of species. Food competition within a species or between species has similar effects.

The time-adjusted 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, energy value). Temporally or spatially staggered occurrence of succession and abundance of species from different trophic levels leads to the interruption of food chains. Temporal offset, the trophic “mismatch”, causes early developmental stages of organisms in particular to become undernourished or even starve to death. Disruptions in marine food chains can have an effect not only on individuals but also on 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 interrelationships between plankton, benthos, fish, marine mammals, and seabirds are controlled by multiple mechanisms. Such mechanisms operate from the bottom of the food chains starting with nutrient, oxygen, or light availability upwards to the upper predators. Such bottom-up control mechanisms can act by increasing or decreasing primary production. Effects emanating from the upper predators downwards, via “top-down” mechanisms, can also control food availability.

The interrelationships within the components of marine food chains are influenced by both abiotic and biotic factors. For example, dynamic hydrographic structures, frontal formation, water stratification and currents play a decisive role in food availability (increase in primary production) and use 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 infestation and epidemics also affect the entire food chain.

Anthropogenic activities also have a decisive influence on the interrelationships 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 chain.

Overfishing of fish stocks, for example, confronts upper predators such as seabirds and marine mammals with food limitations or forces them to develop new food resources. Overfishing can also cause changes at the bottom of food chains.

This can lead to the extreme spread of jellyfish when their fish predators are fished away*. Moreover, shipping and mariculture represent an additional factor 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 affect marine organisms and can lead to changes in trophic conditions.

Natural or anthropogenic impacts on one of the components of marine food chains (e.g. the species spectrum or the biomass of plankton) can influence the entire food chain and possibly threaten and shift the balance of the marine ecosystem. Examples of the very complex interrelationships and control mechanisms within marine food chains have been presented in detail in the description of the individual protected assets.

The complex interrelationships of the various components to each other ultimately lead to changes in the entire marine ecosystem of the North Sea. The changes in the marine ecosystem of the North Sea described in Chapter 2 can be summarised:

- Since the early 1980s, there have been slow changes in the biotic marine environment.
- Since 1987/88, rapid changes in the living marine environment have been observed.

The following aspects or changes can influence the interrelationships between the different components of the living marine environment: Changes in species composition (phyto- and zooplankton, benthos, fish), introduction and partial establishment of non-native species (phyto- and zooplankton, benthos, fish), changes in abundance and dominance ratios (phyto- and zooplankton), changes in available biomass (phytoplankton), extension of the growth phase (phytoplankton, copepods), Delay in the growth phase after a warm winter (spring diatom bloom), food organisms of fish larvae have brought forward the start of growth (copepods), decline of many species typical of the area (plankton, benthos, fish), decline in the food base for upper predators (seabirds), shift of stocks from southern to northern latitudes (cod), shift of stocks from northern to southern latitudes (porpoises).

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 offshore uses. Several shipping routes run through the coastal 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 and Baltic Seas.

Prior to the adoption of the spatial plans (ROP) in 2009 and the associated designation of priority and reservation areas for shipping, only traffic separation areas (TSA) 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 unobstructed shipping routes and thus the added value of the provisions in maritime spatial planning became clear.

The legal situation of shipping is strongly influenced by international regulations. Particular mention should be made here of the United Nations Convention on the Law of the Sea from 10 December 1982 (Law of the Sea Treaty), which guarantees freedom of shipping under Section 58. In addition, internationally applicable rules and standards are set by the IMO. For spatial planning, the designation of traffic separation areas is of particular importance here. These lay down mandatory lane routing in one-way traffic with separate lanes at potential danger points.

The act on the responsibilities of the federation in the area of maritime navigation (Maritime Responsibilities – SeeAufgG) and in particular the various ordinances issued on the basis of this act form the legal basis for measures to avert threats to the safety and ease of traffic and for the prevention of dangers arising from maritime shipping, including harmful environmental impacts.

Important international conventions on environmental protection in maritime transport are the Convention for the Prevention of Pollution from Ships, as amended by the 1978 Protocol (MARPOL 73/78), which contains regulations on the discharge of waste water and ship's waste and on the gradual reduction of air pollutant emissions.

Because the North Sea and Baltic Sea are SO_x 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 nitrogen 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 agreement 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 the North East Atlantic Environmental Strategy (2010) include measures concerning the 'clean ship approach', air pollution (e.g. NOx, SOx), ship noise, the introduction and spreading of non-native species and other measures for preventing, preparing for and combating pollution from ships.

Development of shipping

The average traffic density reflected in the analysis of AIS data shows an increasing demand for space, driven not least by construction, maintenance and supply trips for the growing offshore wind industry, the increasing number of cruise ships and a higher demand for anchorage and shipping space.

With the Maritime Traffic Forecast 2030, the BMVI published the forecast development of the transhipment volume of German seaports (BMVI, 2014). The volume of cargo handled is forecast to increase from 438 million tonnes to 712 million tonnes between 2010 and 2030. This involves transshipment from German and foreign ports and their hinterland traffic using German transport infrastructure. The main drivers for the forecast increase in transhipment volumes are the overall continuing trend towards globalisation and the strong export orientation of the German economy. However, this assumed increase in transshipment* and shipping traffic as a whole is subject to uncertainties and may be significantly lower as a result of 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 purification plants or alternative fuels are used to comply with the NOx and SOx emission limits. The IMO strategy for reducing CO_2 emissions which was adopted in April 2018 will also require alternative fuels and greater energy efficiency (DNV GL 2019).

Impacts on the marine environment from shipping

Shipping causes different impacts on the marine environment. These include illegal offshore oil disposal, 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 effects can be of supra-regional, temporary or permanent character. These can be summarised as follows:

- supra-regional, temporary impact because of oil input, emissions, and the introduction of toxic substances;
- transregional, permanent effect because of the introduction of exotic species.

The following table provides an overview of the effect caused by shipping and their potential impacts on the protected assets. The impacts are predominantly to be classified as legacy impacts (Chapter 2) and as impacts that will occur even if the plan is not implemented.

Table 15: Potential effects of shipping

Use	Effect	Potential impact	Protected assets																
			Benthos	Fish	Seabirds and resting	Migratory birds	Marine Mammals	Bats	Plankton	Biotopes	Biological diversity	Seabed	Site	Water	Air	Climate	Human/ Health	Cultural and material	Landscape
Ship-ping	Underwater Sound	Adverse effect/deter-rent effect		x			x												
	Emissions and introduc-tion of haz-ardous sub-stances (ac-cidents)	Impairment/ damage	x	x	x		x		x	x	x	x		x			x		
	Physical dis-turbance dur-ing anchoring	Adverse effect 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		
	Introduction and spread of invasive species	Change in species composition	x	x	x				x		x								
	Introduction of waste/dis-charges	Impairment/ damage	x	x	x		x		x	x				x			x		
	Risk of colli-sion	Collision			x	x	x												
	Visual agita-tion	Impairment/ scaring effect		x	x														

3.1.1 Seabed

The seabed is influenced by the following effects of shipping:

Input of pollutants:

For operational reasons, shipping generates pollutants that contribute to sediment and water pollution. The introduction of oil causes pollution in water and sediment to varying degrees with pollutants which are partially toxic. Depending on the quantity, type, and composition, oil slicks to carpets can form; these can be widely dispersed 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 effects are independent of the non-implementation or implementation of the plan.

3.1.2 Benthos and biotopes

The following comments are limited to the effects of the uses on benthic communities. Because biotopes are the habitats of a regularly recurring community of species, adverse effects of biotopes have direct impacts on biotic communities.

The effects of shipping on benthos are due to the following factors.

- Oil entry. Even the smallest level of oil pollution poses a risk to living organisms. The effects of chronic oil pollution on birds are well documented. In contrast, there are few studies examining the effects of chronic oil pollution on other organisms. The few investigations show, among other things, a reduced species diversity and number of individuals among the molluscs. Bernem (2003) mainly examines the effects on coastal areas, and identifies salt marshes as particularly endangered habitats. Investigations of the impacts 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 seabed.
- Entry of toxic substances. Since the beginning of the 1970s, effects of TBT on aquatic organisms have been known, primarily in coastal waters, which should not actually be adversely affected by the biocidal action of the chemical. TBT has been shown to have an endocrine effect, i.e. it interferes with the endocrine system of organisms. The TBT is capable of inducing a pathomorphosis called imposex not only in bivalves but also in separately sexed anterior gastropods. Imposex describes a masculinisation of female animals in snail populations. In the female whelk (Buccinum undatum) it also leads to the development of male reproductive organs. Proliferating male genitalia lead to the 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 an extensive international ban on organotin anti-fouling agents in 2008.
- Physical disturbances during anchoring. When ships anchor, there is a local and temporary disturbance of the seabed and thus a small-scale adverse effect on benthic communities.
- Introduction of non-native species. Since 1970, there has been an increasing trend of first discoveries of non-native species. In addition to aquaculture, which makes targeted use of alien species in some cases, the main contributors have been shipping traffic via ballast water, via sediment from ballast tanks and via the hulls of ships (Gollasch, 2003). The spectrum of species introduced ranges from macroalgae to invertebrates. If the alien species find optimal living conditions, they can multiply en masse; this, in turn, can cause great 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 adverse economic effects – such as the Chinese mitten crab (Eriocheir sinensis) and the shipworm (Teredo navalis) – which has meanwhile caused considerable damage since it became firmly established or various phytoplankton species have been native to Germany for a long time (Gollasch, 2003). The International Convention for the Control and Management of Ships' Ballast Water and Sediments has been in force since 2017 and regulates the introduction and spread of organisms with the ballast water of seagoing vessels. The current ballast water exchange in the North Sea is only possible under certain conditions. With bioswales, species are released. However, these are sessile species that require suitable environmental conditions (hard substrates) to colonise and establish themselves when released. The introduction of foreign species through the growth on 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:

- supra-regional, temporary impact because of oil input, emissions, and the input of toxic substances, anchors
- transregional, permanent effect because of the introduction of non-native species.

The aforementioned impacts on benthic communities and biotopes occur regardless of whether the plan is implemented.

3.1.3 Fish

The impacts 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, including especially the larger vessels, emit mostly low-frequency **underwater noise**, which depends on the type of ship, the ship's propeller, and the hull design, among other factors (POPPER & HAWKINS 2019). The sound emitted 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 noise than fish species without swim bladders (flatfish or sand eels). Hearing allows fish 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 noise could mask communication, especially during spawning (DE JONG et al. 2020). Some fish species (e.g. herring or cod) also showed typical avoidance reactions to shipping traffic such as a 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 may differ in a species-specific manner. Even the response of a single species to ship noise can change depending on its life stage (DE ROBERTIS & HANDEGARD 2013). In scientific literature, there are indications of possible behavioural changes as a result of ship noise. However, the results are not sufficiently well-founded in order to draw conclusions in regard to significance. Scientific reviews of the existing literature on possible impacts of ship noise on fish clearly indicate the lack of comparability, transferability, and reproducibility of results (POPPER & HAWKINS 2019). In addition, long-term investigations on the impacts of continuous noise emissions on fish in their natural habitat are needed in order to be able 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 impact of shipping traffic should be mentioned in particular. Shipping can have a severe impact on the marine environment as a result of accidents and the potential release of pollutants, particularly **heavy oil.** Several factors such as the type, condition, and amount of oil determine the degree of the adverse effect (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 investigations on salmon (VAN BERNEM 2003). Bottom-dwelling fish species may be damaged by prolonged contact with oily sediments. Possible consequences include the uptake of hydrocarbons from sediment, the occurrence of certain diseases (including fin rot) and stock decline. There are no known scientific findings from the natural habitat that could be used for a significance assessment.

Fish eggs and juveniles are generally more threatened 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, there has been an increasing trend of first discoveries of non-indigenous species. 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 non-indigenous species find suitable living conditions, mass reproduction can occur. This, in turn, can lead to the displacement of native species because of competition for food and habitats. Investigations on non-indigenous species focus predominantly 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 effects 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 m^3 of plastic waste is found in the North Sea (FEDERAL GOVERNMENT 2020); of this, about one third is attributable to shipping and fishing (BFN 2017). The fish also ingest plastic with food and spread it via the food web. There are currently no systematic investigations on the impacts of plastics on fish fauna that would allow a differentiated assessment. The Thünen Institute of Fisheries Ecology is working on the PlasM project, which is expected to run until 2021. The project is focussed on the risk posed by plastic in the marine environment.

The aforementioned impacts of shipping on fish fauna occur regardless of whether the plan is implemented

3.1.4 Marine mammals

Impacts of shipping traffic on marine mammals can result from, among other things: noise emissions, pollution during normal operation, or accidents with ships. During normal operation, shipping poses a potential threat to marine mammals. The effects are area-specific and of low, medium or even high intensity. The effects are also temporary or recurrent in an area-specific way, such as along busy shipping routes.

Direct disturbance of marine mammals by noise emissions is 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. Ship collisions with harbour porpoises and seals are also not known.

In recent years, numerous studies have been carried out to investigate the impacts of ship noise. Measurement, modelling, and characterisation of ship-radiated noise in marine areas with different abiotic environmental parameters has produced valuable insights (ARVESON & VENDITIS, 2000, WALES ET AL., 2002, HATCH ET AL, 2008, DEROBERTISet 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 highly 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. The results revealed that parameters such as speed over the seabed, width of the ship, and class as well as the distance of the measuring hydrophone from the ship and the surface reflection greatly influence the results. Even if the studies assume that a reduction in noise input can be accompanied by a reduction in speed, it has become 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).

The measurement of sound emitted by ships in deep waters was standardised in 2017 (ISO 17208-:2016, ISO 17208-2:2019).

A majority of international studies have also focused on the impacts of noise 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 assume that interference may occur as a result of masking of communication, especially in bearded whales, which echo and communicate in a low frequency range that overlaps with ship sounds. Evidence can be found in numerous studies; however, their results are often not comparable with each other, transferable, or 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. In addition, marine mammals have developed adaptive mechanisms to maintain communication even in noisy areas. One of the known adaptations of whales to the acoustic environment in the oceans is the Lombard effect. The Lombard effect is 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 (e.g. the harbour porpoise) are also capable of increasing the volume and frequency of vocalisation as well as changing the frequency spectrum. This adaptation is a survival strategy to forage effectively and efficiently, escape predators, and maintain mother-calf contact, as well as to seek out conspecifics (ERBE ET AL., 2019).

The assessment of the impacts of underwater noise, including noise emitted by ships, has been 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 findings were obtained from 2016 to 2020 as part of the EU research project JOMOPANS (Joint Monitoring and Assessment Programme for the North Sea), taking into consideration the results from the EU project BIAS (Baltic Sea Information on the Acoustic Soundscape). The regular assessments of OSPAR and HELCOM also use the current findings. Finally, as part of the implementation of the MSFD, the TG-Noise expert group of the EU Commission is involved in the development of standardised methods and criteria for the assessment of continuous underwater noise with a focus on noise emitted by ships while taking the current state of knowledge into consideration. The results of the TG-Noise are expected after the completion of the present report and will be decisive for the assessment of the Good Environmental Status with regard to continuous underwater noise. Based on the standardised methods and criteria, measures to avoid and mitigate impacts will be designed and implemented throughout Europe.

In recent years, studies have been carried out on concepts for avoiding and mitigating the impacts of noise emitted by ships, and projects of a model nature have been developed that provide indications of possible implementable 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 guidance on reducing underwater noise from commercial shipping (IMO, 2014). The pilot projects dealing with the design and implementation of noise abatement measures by shipping include Project ECHO through the Port of Vancouver, Canada. Voluntary speed reduction has shown initial positive signals with regard to the occurrence and behaviour of southern resident killer whales (ECHO ANNUAL REPORT, 2020, RUTH ET AL., 2019).

Shipwrecks can cause discharges of environmentally hazardous substances such as oil and chemicals. Direct mortality as a result of oil contamination can be expected only in the case of major oil spills (GERACI and ST AUBIN 1990; FROST and LOWRY, 1993). Oil spills can cause lung and brain damage in marine mammals. Long-term consequences of an oil spill also included 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 cleaning agents from tank cleaning, ballast water containing non-indigenous organisms and solid waste are released into the marine environment (OSPAR, 2000). Pollutants discharged from ships into the sea can accumulate in food chains, thereby contributing to pollution and contamination. Impacts on marine mammals via the accumulation of pollutants in food chains are also possible.

Impacts at the population level can hardly be assessed according to the current state of knowledge. It is therefore recommended that all uses always follow the precautionary principle (Evans, 2020).

The non-implementation of the plan would not affect the existing or described impacts of shipping on harbour porpoises, harbour seals and grey seals.

3.1.5 Seabirds and resting birds

The impacts of shipping traffic 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 deterrent or avoidance reactions in species sensitive to disturbance. According to a current study by FLIEßBACH et al. (2019), red-throated divers, black guillemots, black-throated divers, white-winged scoter, and red-breasted mergansers are among the most sensitive species to shipping traffic. The most common reaction of the birds is to fly away. Escape distances vary between species and individuals and can be related to different 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 as a result of visual disturbance are to be expected especially along busy traffic routes or traffic separation areas. The effects of visual disturbance caused by shipping on seabirds and resting birds depend on the regional and temporal occurrence of shipping. Findings on the responses of divers to ships indicate that the duration and intensity of the deterrent response may be related to ship type 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 mortalities in the southeastern coasts of Newfoundland in 1984–1999 were contaminated with oil from ship operations. Auks 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, thereby contributing to pollution and contamination. Shipwrecks can also cause massive discharges 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, shag breeding colonies affected by the oil spill experienced up to 50% reduced breeding success compared to undisturbed breeding colonies (VELANDO et al. 2005a). Indirect impacts of the "Prestige" accident on the breeding success of the shag were also found: high contamination in sediment, plankton, and benthos reduced the sand eel population. The reduction of sand eels has, in turn, influenced the breeding success of the shag. In 2003, based on long-term data, fewer breeding pairs successfully bred than expected. The condition of the chicks was also exceptionally weak because of lack of food or reduced food quality (VELANDO et al. 2005b).

The above-mentioned effects on seabirds and resting birds are independent of the non-implementation or implementation of the plan.

3.1.6 Migratory birds

For migratory birds, shipping impacts consist of visual stimuli and the input of pollutants. Migratory birds can be attracted at night by the ship’s lights. This is particularly true for nights with poor visibility conditions caused by clouds, fog and rain, among other things. The possible consequence is collisions.

Migratory birds are not very likely to be endangered by oil or pollutants. Only those migratory birds (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) would be affected. The consequence would be that the birds die because of the oiling of their plumage and the absorption of oil into the gastrointestinal tract because of their preening behaviour or the consumption of oily food.

The above effects on migratory birds are independent of the non-implementation or implementation of the plan.

3.1.7 Bats and bat migration

The effects of shipping on bats are largely unknown. There are only isolated reports of bats found on ships. WALTER et al. (2005) have summarised such observations/findings on ships during investigations for offshore wind energy projects. It is assumed thereafter that attraction to ships can occur.

Insects can be attracted to ships by lighting and heat generation. Bats in search of food can be attracted by the insects as a result. In addition, it is 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 effects on bats are independent of the non-implementation or implementation of the plan.

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 3.1.8 contribute to climate change. Globally, maritime transport accounts for 2.2% of greenhouse gas emissions (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, relocate, or widen fairways (e.g. through dredging) can lead to the destruction of the neighbouring underwater cultural heritage. Furthermore, there is a threat to the protected asset of underwater cultural heritage, especially in shallower waters, because ship propellers can cause turbulence in the sediment, which has an erosive effect on the sediment layers. Destruction can also be caused by anchor relocation, especially during construction measures with anchor-positioned workboats.

Indirectly, the increasing trend since 1970 of unintentionally introducing non-native species via the ballast water and the ship's hull itself (Gollasch 2003) poses the greatest threat to the underwater cultural heritage. Three species of teredinids are active in domestic waters, Teredo navalis being the best-known representative among these, which was detected in the Baltic Sea as early as 1872 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 a migration of further destructive organisms that are adapted to a different tolerance range and which can penetrate previously undisturbed areas.

An indirect consequence of recreational boating is recreational diving in the EEZ. In the past, objects were removed from historical wrecks or even deliberately extracted as demonstrated by the example of the wreck of the SMS Mainz, which was looted by Dutch divers in 2011 (Huber & Knepel 2015).

In the past, explosive ordinance disposal teams blasted wrecks from the time of the World Wars on the suspicion that there might still be ammunition on board. Here, safety aspects and the protection of cultural heritage must be weighed.

3.2 Offshore wind energy

The increasing demand for space resulting from offshore wind energy and the ambitious goals of the federal government for the use of offshore wind energy use were the main reasons for drawing up the 2009 spatial plans for the German EEZ of the North Sea and Baltic Sea. The preparation of spatial plans was an explicitly mentioned measure to promote the expansion of renewable energies.

When the 2009 regional development plans were adopted, an initial offshore wind farm, the alpha ventus test field, with 12 individual turbines, was nearing completion. There are now 21 wind farms in the EEZ of the North Sea with a total of 1,399 installations 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 SDP 2019 (currently being updated and amended), up-to-date sectoral planning exists in order to guide the design of offshore wind energy development and electricity grid connections.

The current SDP 2020 defines areas N-1 to N-13 for offshore wind energy in the EEZ of the North Sea 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 Offshore Wind Energy Act and other regulations adopted by the federal cabinet on 3 June 2020. In connection with the construction and operation of wind turbines, various impacts on the marine environment may result. These include local habitat loss as a result of permanent land sealing, chilling and barrier effects, and a resulting habitat loss for avifauna.

Also to be considered are potential impacts of maintenance and service traffic.

For the assessment of the designations for offshore wind energy, the following possible impacts are assessed:

Table 16: Potential effects of offshore wind energy (t = temporary).

Use	**Effect**	**Potential impact**	**Protected assets**																
			Benthos	Fish	Seabirds and rest-	Migratory birds	Marine Mammals	Bats	Plankton	Biotopes	Biological diversity	Seabed	Site	Water	Air	Climate	Human/ Health	Cultural and mate-	Landscape
Areas for offshore wind energy	Placement of hard substrate (foundations)	Modification of habitats	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 relocation	Modification of habitats	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 deterrent 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/ scaring effect		x t			x												
		Potential disruption/damage		x t			x												
	Visual unrest due to construction activity	Local deterrent and barrier effects		x t	x t														
	Obstacle in airspace	Deterrent 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 Seabed

The use of "wind energy at sea" has the following effects on the seabed:

Wind turbines

The wind turbines and platforms have a locally limited environmental impact with regard to the seabed, which is the subject of the protection. The sediment is only permanently affected in the immediate vicinity by the introduction of the foundation elements (including scouring protection, if necessary) and the resulting land use. To protect against scouring, either scour protection in the form of mudmats or stone packing is placed around the foundation elements or the foundation piles of deep foundations are placed correspondingly deeper into the seabed. 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 taken into consideration. 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 seabed. 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 a lattice-shaped frame structure consisting of steel tubes and struts, the so-called jacket structure, is usually used as a stiffening structure for both deep foundations and for suction bucket foundations.

Construction-related impacts: When the foundations of the wind turbines and platforms are being installed, sediment is briefly churned up and turbidity plumes are formed. The extent of resuspension depends essentially on the fine grain content in the seabed. Since the surface sediment of the North Sea EEZ within the priority and reserved areas mainly consists of fine and medium grain sand and coarse sand in some locations, the sediment that is released will quickly settle directly at the construction site or in its immediate vicinity. The anticipated impairments caused by increased turbidity will be limited to a small area. Pollutants and nutrients can be released from the sediment into the groundwater in the short term. The potential introduction of pollutants into the water column by churned up sediment is negligible due to the relatively low fine-grain content (silt and clay) and the low pollutant load, and also the relatively rapid resedimentation of the sand. This also applies against the background that the sandy sediments are naturally (e.g. during storms) churned up and moved by sea waves touching the ground and appropriate currents. Impacts in the form of mechanical stress on the seabed as a result of displacement, compaction, and vibrations that are to be expected in the course of the construction phase are assessed as low because of their small-scale nature.

Due to the type of installation, the seabed is only permanently sealed locally to a very limited extent by the insertion of the foundation elements of deep-foundation wind turbines or platforms. The areas that are affected essentially consist of the diameter of the foundation piles, plus any scour protection that may be required. In the case of transformer and converter platforms, which are almost exclusively supported on jacket structures (without scour protection), the area that is required (sealing) is 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 type of foundation in this case is the monopile. A monopile with a diameter of 8.5 m, including scour protection, requires a surface area of around 1400 m^2. The area that is required for suction bucket foundations is approximately the same of that of a monopile.

In the case of a gravity-based platform, the area that is sealed because of the installation is significantly greater than in the case of deep foundations. Including scour protection measures, the area that is required is probably ten to twenty times that of a deep-foundation platform.

Because of the interrelationship between the foundation and the hydrodynamics in the immediate vicinity of the installation, the sandy sediments may be permanently stirred up and rearranged. Scouring may also occur in the immediate vicinity of the installations. According to previous experience, flow-induced permanent sediment rearrangement can only be expected in the immediate vicinity of the platform. This will occur locally around the individual foundation piles (local scour) according to the findings from the accompanying geological investigations in the “alpha ventus” offshore test site (LAMBERS-HUESMANN & ZEILER 2011) as well as on the FINO1 and FINO3 research platforms. Because of the prevailing properties of the seabed and the predicted small extent of the scouring, no significant changes to the substrate are anticipated.

Submarine cable systems

For construction reasons, the turbidity of the water column increases because of sediment uplift during cable-laying work, and is distributed over a bigger area because of the influence of tidal currents. The extent of the resuspension mainly depends on the laying method and the consistency of the seabed. Due to the predominant sedimentary composition in the North Sea EEZ, most of the sediment released will settle directly at the construction site or in its immediate vicinity. In the process, the suspension content decreases again to the natural background values because of dilution effects and sedimentation of the stirred-up sediment particles. The impairment that is anticipated because of increased turbidity remains locally limited. The results of investigations of different methods in the North Sea reveal that the seabed levels off relatively quickly in some cases due to the natural sediment dynamics along the affected routes. Pollutants and nutrients can be released from the sediment into the groundwater in the short term. The possible release of pollutants from the sandy sediment is negligible due to the low proportion of fine grains and the low concentrations of heavy metals in the sediment. Impacts in the form of mechanical stress on the seabed as a result of displacement, compaction, and vibrations that are to be expected in the course of the construction phase are assessed as low because of their small-scale nature.

For operational reasons, energy losses may occur in the form of heat given off into the surrounding sediment. The heat emission results from the thermal losses of the cable system during energy transmission.

By way of a summary, the potential impacts of the currently planned wind energy installations, platforms and undersea cable systems on the protected seabed are local and independent of regional planning.

Spatial plan (ROP) and site development plan (SDP) – priority areas and reservation areas

The current status regarding the expansion of offshore wind energy is set out in SDP 2019, which – spatially speaking – covers the *priority areas* for wind energy in the ROP. For this study area, the impacts described above were therefore examined during the course of preparing the FEP 2019. As a result, no significant impacts on the seabed as a protected resource were found, particularly since the affected areas mainly consist of poorly structured seabed with a homogeneous sediment distribution consisting of fine and medium grain sand.

If the FEP is not implemented, the result would probably be an installation that was less coordinated and possibly a greater number of cable systems or longer undersea submarine cable systems. This could lead to a higher area use and thus to an increase in the potential impacts on the protected asset seabed compared with the implementation of the SDP. If the FEP is not implemented, there would probably also be a greater number of cable crossings with undersea cables that are already in operation. This would require an increased amount of rock filling, even in areas with a predominantly homogeneous sandy seabed. In the case of the crossing disused telecommunication cables, these are usually cut, meaning that the cut cable ends have to be prevented from floating by attaching concrete weights. This would result in additional seabed sealing and the introduction of artificial hard substrate.

In addition to priority areas, the ROP also provides for *reservation areas* in the EEZ of the North Sea. If the plan is not implemented, the development of offshore wind energy in these areas is likely to be less coordinated.

3.2.2 Benthos and biotopes

Benthic communities and biotopes would also be partially affected by the impacts of different uses if the plan is not implemented. Furthermore, the warming of the water that has already begun as a result of climate change is expected to continue in the future. This also has impacts on benthic communities and can lead to the establishment of new species or to a shift in the species spectrum as a whole. However, this development is independent of whether the plan is implemented.

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 use of surface and thus an increase in potential impacts on benthos and biotopes compared with the implementation of the plan. Possible impacts result from the installation of the foundations for the wind turbines and platforms. During the construction phase, there could be impacts on benthic communities as a result of the 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 installations and platforms, changes in the existing species composition may occur as a result of the introduction of artificial hard substrate.

Because the designations 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 impacts of OWF on fish fauna as a result of construction, installation, and operation are spatially and partly also temporally limited and are essentially concentrated on the area of the planned project. In the following, impacts of the different wind farm phases are presented in detail.

<u>Construction-related effects</u>

- Noise emissions due to the ramming of the foundations
- Sedimentation and turbidity plumes

In the area of the project, **noise emissions** are to be expected as a result of the use of ships, cranes, and construction platforms as well the installation of the foundations and, if necessary, the introduction of scour protection. From scientific literature, it is known that pile driving under water produces high sound pressures in the low-frequency range. All fish species studied so far and their life stages can perceive noise 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 impacts of noise on fish comes from laboratory studies (WEILGART 2018). The range of perception and possible species-specific behavioural responses in the marine habitat have so far not been investigated to any great extent. 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 be scared away. 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. This effect was found at a distance of 1,400 m or closer from a pile-driving sound source without any noise abatement (DE BACKER et al. 2017). Such investigations indicate that considerable disturbance or even death of individual fish in the vicinity of the pile driving sites is possible. Hydroacoustic measurements showed that construction measures (pile driving and other construction activities) in the test site “alpha ventus” resulted in a strongly reduced stock of pelagic fish relative to the surrounding area (KRÄGEFSKY 2014). However, after temporary displacement, the fish are likely to return after the noise-intensive construction measures have ended. Investigations on noise impacts 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 cause **sediment turbulence and turbidity plumes**, which – albeit limited in time and varying according to species – can cause adverse physiological effects on the fish fauna, especially on fish spawn. However, significant impacts on fish fauna as a result of sediment turbulence, turbidity plumes, and sedimentation are not expected. Detailed information on this can be found in Chapter 3.4.3.

System-related effects

- Area use
- Introduction of hard substrate
- Expected fishing exclusion
- Operating noise

The construction of the foundations of the Offshore Wind Energy Plants (OWEP) and technical platforms as well as the scour protection will overbuild habitats, which will no longer be available for the fish. This results in permanent **habitat loss** for demersal fish species and their food source, macrozoobenthos, due to local overbuilding. However, this habitat loss is limited to the immediate, small-scale location of the individual OWEP and platforms.

The construction of wind farms changes the structure of the seabed of the North Sea, which is often uniformly sandy, by 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, GLAROU et al. 2020). In the vicinity of Norwegian oil platforms, higher catches of cod and pollack have been obtained than before their construction (VALDEMARSEN 1979, SOLDAL et al. 2002). 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 an oil rig in the Gulf of Mexico. Transferred to the foundations of the wind turbines, it can be assumed that, because of the distance of the individual installations from each other, each individual foundation, regardless of the foundation type, acts as a separate, relatively unstructured substrate and that the impact does not cover the entire wind farm area.

COUPERUS et al. (2010) used hydroacoustic methods to detect up to 37 times higher concentrations of pelagic fish in the vicinity (0–20 m) of wind turbine foundations compared with the areas between the individual wind turbines. Reubens et al. (2013) found significantly higher concentrations of pout on the foundations than over the surrounding soft substrate; these fed predominantly on the growth on the foundations. Glarou et al. (2020) reviewed 89 scientific studies on artificial reefs; of these, 94% 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 OWF could be the locally more extensive food availability and protection from currents and predators (Glarou et al. 2020).

Recent biological investigations 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 these initial findings of increased productivity can be transferred to other fish species. Higher fish abundance and higher biodiversity in the wind farm areas could lead to a change in dominance relationships within the fish community as a result of the increase in predatory fish and thus enhance the feeding pressure on prey fish species.

The restriction of fishing in the wind farm areas, which is to be expected on the basis of the legal framework and past practice, could have positive effects on the fish population. Associated negative fishing effects such as disturbance or destruction of the seabed and catch and by-catch of many species would be eliminated. Because of the lack of fishing pressure, the age structure of the fish fauna within the development area could develop again towards a more natural distribution 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 growth of wind turbines with sessile invertebrates could favour benthophagous species and make a larger and more diverse food source accessible to 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 impacts to the population level of fish. To date, the effects on fish fauna that could result from the exclusion 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 the prevailing meteorological conditions in the North Sea will basically allow the WTGs to be operated almost permanently. The sound emitted by the WT is therefore expected to be permanent. Investigations 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 installation. With increasing distance to the installation, the noise levels towards the wind farm centre 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 noise emitted by the installations cannot be clearly separated from other sound sources such as waves or ship noise (Matuschek et al. 2018). Previous investigations on the impacts of continuous noise emissions on fish did not demonstrate any 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. Protection of the marine environment (e.g. by taking into consideration the ecosystem approach and the precautionary principle) may be more difficult to ensure if the plan is not implemented.

3.2.4 Marine mammals

Construction-related: Threats may be caused to harbour porpoises, grey seals, and seals by noise emissions during the construction of offshore wind turbines and the transformer station if no preventative and mitigation measures are taken. Depending on the foundation method, impulse noise or continuous noise can be introduced. The input of impulse noise, which occurs when driving piles with hydraulic hammers, has been well investigated. The current state of knowledge about impulse noise contributes significantly to the development of technical noise mitigation systems. In contrast, the current state of knowledge on the input of continuous noise 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 when constructing foundations for offshore wind turbines. The sound event level (SEL) shall not exceed 160 dB (re 1 µPa) outside a circle with a radius of 750 m around the pile driving or insertion site. The maximum peak sound pressure level should not exceed 190 dB if possible. The recommendation of the UBA does not contain any further specification of the SEL noise protection value (http://www.umweltdaten.de/publikationen/fpdf-l/4118.pdf, status: May 2011).

The noise protection value recommended by the UBA has already been developed through preliminary work by various projects (University of Hanover, ITAP, FTZ 2003). For precautionary reasons, "safety margins" were taken into consideration (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 pulses 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, which can last several hours, have a much higher damage potential than a single pile driving blow. At present, it is unclear how much of a discount should be applied to the aforementioned limit value for a sequence of individual events. A reduction of 3 dB to 5 dB for each tenfold increase in the number of pile driving pulses is being discussed among experts. Because of the uncertainties shown here in the assessment of the impact duration, the limit value used in approval practice is below the limit value proposed by Southall et al. (2007).

In the context of drawing up measurement regulations for the survey and assessment of underwater noise from offshore wind farms, the BSH has detailed and standardised as far as possible the specifications from the UBA recommendation (UBA 2011) as well as the findings of the research projects with regard to noise protection values. In the measurement regulations for underwater noise measurements of the BSH, the SEL_5 value is defined as the assessment level (i.e. 95% of the measured individual sound event levels must be below the statistically determined SEL_5 value) (BSH 2011). The extensive measurements within the framework of the efficiency control show that the SEL_5 is up to 3 dB higher than the SEL_{50}. Thus, by defining the SEL_5 value as an assessment level, a further tightening of the noise protection value was made 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 (SEL_5) outside a circle with a radius of 750 m around the pile driving or placement site must not exceed 160 dB (re 1 µPa) in order to be able to exclude adverse effects on harbour porpoises with the necessary certainty.

Initial results concerning the acoustic resilience of harbour porpoises have been obtained as part of 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

(TTS) was detected for the first time in a captive animal at 4 kHz. It was also shown that the hearing threshold shift lasted for more than 24 hours. Behavioural changes were 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 volume, the duration of the signal also determines the impacts on the exposure limit. The exposure limit decreases with increasing duration of the signal (i.e. continuous exposure can cause damage to the hearing of the animal even at lower volumes). Based on these latest findings, it is clear that harbour porpoises suffer a hearing threshold shift above a level of 200 decibels (dB) at the latest. This can also lead to damage to vital sensory organs.

The scientific findings that have led to the recommendation or designation of 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 airguns or air pulsers (LUCKE et al. 2009).

Without the use of noise mitigation measures, significant adverse effects on marine mammals during pile driving of the foundations cannot be ruled out. The pile driving of the wind turbines and the transformer station will therefore be permitted only in the specific approval procedure with the use of effective noise mitigation measures. Principles will be included for this purpose. These state that pile driving during the installation of the foundations of offshore wind turbines and platforms is to be carried out only in compliance with strict noise mitigation measures. In the specific approval procedure, extensive noise mitigation measures and monitoring measures are ordered to comply with applicable noise protection values (sound event level (SEL) of 160 dB re 1 µPa and maximum peak level of 190 dB re 1 µPa at a distance of 750 m around the pile driving or placement 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 reducing underwater noise show that the use of suitable systems can significantly reduce or even completely prevent the effects of noise input on marine mammals (Bellmann, 2020).

Taking into consideration the current state of knowledge, conditions will be imposed as part of the specification of the foundation types to be erected in the approval procedure with the objective of avoiding impacts on harbour porpoises caused by noise as far as possible. The extent of the required conditions is determined at the approval level on a location- and project-specific basis from the assessment of the constructive design of the respective project on the basis of species protection law and site protection law requirements.

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

The approval notices of the BSH contain two orders to protect the marine environment from noise pollution caused by pile driving:

a) Reduction of noise* input at the source: Mandatory use of low-noise working methods according to the state of the art when installing foundation piles and mandatory restriction of noise emissions during pile driving. The primary purpose of the order is to protect marine species from impulsive noise inputs by avoiding killing and injury.
b) Avoidance of significant cumulative impacts: The propagation of noise emissions must not exceed defined areas of

the German EEZ and nature conservation areas. This ensures that sufficient high-quality habitats are available for the animals to escape at all times. The arrangement primarily serves to protect marine habitats by preventing and minimising disturbances caused by impulsive sound input.

The order under a) specifies the mandatory noise protection values to be complied with, the maximum duration of the impulsive noise input, and the use of technical noise mitigation 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 mitigation of significant cumulative impacts or disturbance to the harbour porpoise population that may be caused by impulsive noise inputs. The provisions are derived from the BMU 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 sensitive period of the harbour porpoise 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 “Sylter Außenriff – Östliche Deutsche Bucht” 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 that marine habitats are protected, the BMU noise abatement concept of (2013) states that, depending on the location of a project in the German EEZ or its proximity to nature conservation areas, additional measures are required during foundation work. Additional measures will be issued by the BSH within the scope of the third construction approval, taking the site-specific and project-specific characteristics into consideration.

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 can be expected locally around the pile driving site and for a limited time, whereby – as explained above – the duration of the work also has impacts on the exposure limit. In order to prevent a resulting threat to the marine environment, the specific approval procedure must include an order to minimise the effective pile driving time (including the entanglement). The effective pile driving time to be observed in each case (including deterrence) will be specified later in the approval procedure on a location- and installation-specific basis. As part of the enforcement procedure, the coordination of noise-intensive works with other construction projects is also reserved in order to prevent or reduce cumulative effects.

On the basis of the function-dependent importance of the areas for harbour porpoises and taking the noise abatement concept of the BMU (2013) into consideration for avoiding disturbances and cumulative effects, the provisions made in the regional development plan (FEP, 2019), the specifications within the scope of the suitability check and the conditions imposed within the scope of individual approval procedures for reducing noise input, the potential effects of noise-intensive construction work on harbour porpoises are not considered to be significant. By protecting open space in nature conservation areas, defining the reserve area and implementing the specifications of the BMUB's noise abatement concept, the impairment of important feeding and breeding grounds for harbour porpoises is ruled out.

According to current state of knowledge,operational noise from the wind turbines and the transformer platform has no impacts 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 given no indications of avoidance by wind farm-related shipping traffic. So far, avoidance has been observed only during the installation of the foundations; this may be related to the large number and varying operating conditions of vehicles on the site.

The standardised measurements of the continuous noise 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. However, with increasing distance from the installation, the noise from the installation is only insignificantly different from the ambient sound. At a distance of only 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 noise emitted by the installations cannot be clearly identified from other sound sources (e.g. waves or ship noise) even at short distances. The wind farm-related shipping traffic was also hardly differentiated from the general ambient noise, which is introduced by various sound sources such as other shipping 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 that 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 noise.

In the measurement regulations for recording and evaluating underwater noise (BSH, 2011), a level difference between impulse and background noise of at least 10 dB is required for a technically unambiguous calculation of impulse noise during pile driving. For the calculation or assessment of continuous noise measurements, on the other hand, there is no minimum requirement in this respect because of a lack of experience and data. In the airborne noise range, a level difference of at least 6 dB between installation and background noise is required for the unambiguous assessment of installation 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 does not stand out clearly from the background noise level.

The results from the measurements of underwater noise show that such a 6 dB criterion based on airborne nose can at most be fulfilled in the immediate vicinity of one of the installations. However, this criterion is no longer fulfilled even at a short distance from the edge of the wind farm. As a result, from an acoustic point of view, the sound emitted by the operation of the wind turbines outside the project areas does not clearly differ from the existing ambient noise.

The biological relevance of continuous noise on marine species and in particular on harbour porpoises has not yet been reliably clarified. Continuous noise is the result of emissions from various anthropogenic uses as well as 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 that were not observed in the immediate vicinity of noise sources can no longer be assigned to a specific source.

Behavioural changes are mainly 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 to capture food, escape predators, and communicate with conspecifics. For this reason, behavioural changes always arise situationally and in varying degrees.

There are indications of possible behavioural changes as a result of ship noise reported in scientific literature. However, the results are not sound enough to be able to draw conclusions in regard to the significance of behavioural changes or even develop and implement appropriate mitigation measures.

However, scientific reviews of the existing literature on possible impacts of ship noise on cetaceans and fish clearly indicate the lack of comparability, transferability, and reproducibility of results (Popper & Hawkins, 2019, Erbe et al. 2019).

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

As a result of the SEA, it can be stated that, according to the current state of knowledge, no significant impacts on the protected asset marine mammals are to be expected from the construction and operation of wind turbines and the transformer platform.

Non-implementation of the plan would have had an influence on the existing or described effects of wind energy production on harbour porpoises, harbour seals and grey seals to the extent that it would not have been possible to plan the expansion in an orderly manner, taking specific objectives and principles into consideration.

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; however, the nature and extent of these impacts are 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 resulting from the lighting of the construction site and the construction site vehicles cannot be ruled out.

Operational and plant-related: Erected wind turbines can be an obstacle in the airspace and also cause collisions with the vertical structures for seabirds and resting birds (GARTHE 2000). It is difficult to estimate the extent of such incidents so far because it is assumed that a large proportion of the collided birds* do not touch down on a solid structure (HÜPPOP et al. 2006). However, the risk of collision is estimated to be very low for disturbance-sensitive species such as red-throated and black-throated divers, since they do not fly directly into or near the wind farms due to their avoidance behaviour. Furthermore, factors such as manoeuvrability, flight altitude, and proportion of time spent flying determine the risk of collision of a species (GARTHE & HÜPPOP 2004). The risk of collision for seabirds and resting birds must therefore be assessed differently depending on the species.

For the estimation of a possible risk of collision for seabirds and resting birds with offshore wind turbines, the corresponding height parameters of the installations are an important key figure. In the ROP, bandwidths for the height parameters of currently installed or potential turbine types were included according to the current technical developments of wind turbines (cf Chapter 4.2). This takes into consideration wind farm projects that are already in operation as well as those that will come into operation within the framework of the transitional system and the first commissioning years of the central system in zones 1 and 2. Another range of turbines represents systems which could potentially be installed in future wind farm projects in zones 3 to 5. For wind farm projects which have already been realised or future wind farm projects in zones 1 and 2, information or assumptions are available for 5 to 12 MW turbines which have 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 of 12 to 20 MW installations with 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 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.

As part of StUKplus, the "TESTBIRD" project used rangefinders to determine the flight altitude distribution of a total of seven species of sea birds and resting birds. The gull species herring gull, lesser black-backed gull, and greater black-backed gull flew at altitudes of 30–150 m in the majority of the recorded flights. Species such as kittiwake, common gull, little gull, and the northern gannet, on the other hand, were observed mainly at lower altitudes up to 30 m (MENDEL et al. 2015). A recent study at the Thanet Offshore Wind Farm in England investigated the flight height distribution of northern gannet, kittiwake, and the gull species herring gull, greater black-backed gull, and lesser black-backed gull, also using the rangefinder (SKOV et al. 2018). The flight level measurements of great black-backed gulls and gannets revealed heights comparable to those determined by Mendel et al. (2015). Black-legged kittiwakes, on the other hand, were mostly observed at an altitude of about 33 m.

In general, greater and lesser 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), which investigated not only the flight altitude but also the immediate, small-scale, and large-scale evasive behaviour of the species considered. The investigations using radar and thermal imaging cameras also revealed low nocturnal activity, which means that there is only a low risk of collision for the species in question at night.

The terns* listed in Appendix I of the V-RL are extremely agile flyers and prefer low flight altitudes (GARTHE & HÜPPOP 2004). Only low collision risks can therefore generally be assumed for these species.

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

Red-throated divers and black-throated divers show very pronounced avoidance behaviour towards offshore wind farms. From the wind farm projects in area EN5, recent 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 about 15 km (IFAÖ 2018). For the wind farm projects in Area EN4, effects on the diver distribution were demonstrated up to 10 km from the wind farm(IBL UMWELTPLANUNG et al. 2017a, IBL UMWELT planung et al. 2018, IBL UMWELTPLANUNG et al. 2019). For Areas EN1 to EN3, effects were found 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 consideration data from wind farm monitoring in the EEZ as well as research data and data from Natura 2000 monitoring, found a statistically significant decrease in diver abundance over all built-up areas in the EEZ up to 10 km starting from the periphery of a wind farm (GARTHE et al. 2018). This was also the conclusion of a study commissioned by the BWO, which used a modified data source and different statistical analysis methods than the FTZ study (BIOCONSULT SH et al. 2020). The DIVER research project used an independent method to determine avoidance effects with the telemetry of divers in the German EEZ, in addition to the usual digital aircraft-based recording of sea birds and resting birds. Significant avoidance effects up to a distance class of 10–15 km also emerge from the telemetric investigations of the DIVER research project in the area of wind farms in areas EN4 and EN5 (BURGER et al. 2018). The large-scale digital surveys conducted west of Sylt as part of the HELBIRD research project revealed statistically significant avoidance effects up to 16.5 km from a wind farm. The increase in diver density with increasing distance from the wind farm was strongest within 10 km (MENDEL et al. 2019). With all of the above-mentioned parameters, it should be noted that these distances do not represent total avoidance, but partial avoidance with increasing diver densities up to the relevant distances from a wind farm. One thing that all of the studies have in common is the observation that divers avoid the actual wind farm area (footprint).

In order to quantify the loss of habitat, early decisions concerning individual approval procedures were based on a scaring distance of 2 km (defined as complete avoidance of the wind farm area including a 2 km buffer zone) for divers. The assumption of a habitat loss of 2 km was based on data from the monitoring of the Danish wind farm “Horns Rev” (PETERSEN et al. 2006). The recent study by GARTHE et al. (2018) shows more than a doubling of the shooing distance to an average of 5.5 km. This scaring distance, which is also known as calculated total habitat loss, is based on the purely statistical assumption that there are no divers within 5.5 km of an offshore wind farm. The study commissioned by the BWO showed a calculated total habitat loss ('theoretical habitat loss') of 5 km for wind farm projects in the entire study area under consideration and therefore provided a comparable result. In the individual consideration of a northern and a southern sub-area, a calculated total habitat loss of 2 km in the southern sub-area indicated that there were regional differences. However, for wind farm projects in the northern sub-area, which includes the main concentration area, the overriding value of 5 km was confirmed (BIOCONSULT SH et al. 2020).

All available results from research and monitoring show unanimously that the avoidance behaviour of divers towards wind farms is much more pronounced than was previously assumed.

For other species such as northern gannet, razorbill, little gull, and northern fulmar, 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 a number of factors. DIERSCHKE et al. (2016) compiled findings on the behaviour of seabirds from 20 European wind farms. From the studies that were taken into consideration, it was found that Common Guillemots appear to react differently depending on the location of an offshore wind farm. In the wind farms considered, complete avoidance of the OWF area, partial avoidance up to adjacent areas, or no avoidance at all was observed (DIERSCHKE et al. 2016). The authors attribute these differences to food availability at the respective location. MENDEL et al. (2018) add a seasonal aspect to the avoidance behaviour of guillemots. Using digital flight transect studies in the area north of Helgoland, the authors found differences in the avoidance behaviour before and during the breeding season. In spring, for example, a significant reduction in density up to 9 km from the wind farm projects north of Helgoland was observed, while no effect radius was found during the breeding season. MENDEL et al. (2018) link these differences to the reduced range and attachment to the breeding colony on Helgoland during the breeding season. In spring, however, guillemots are independent of a specific range and generally show a more westerly distribution (MENDEL et al. 2018). In a recent study, PESCHKO et al. (2020) confirmed the breeding season behaviour found by MENDEL et al. (2018) by using transmittered guillemots in the same area of investigation. 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 seasonally broken down. Scientific findings on seasonal and site-related avoidance behaviour during the high season of winter and autumn are not currently available.

It can also be assumed that fish stocks will recover during the operational phase as a result a regular ban on fishing within the wind farms accompanied by a ban on ships entering the area. In addition to the introduction of hard substrate, this could increase the species range of fish present and provide an attractive food supply for foraging seabirds.

If the ROP were not implemented, there would be less spatial coordination in the planning of wind farm projects. Area use would likely be increased as a result; this, in turn, could have impacts on species sensitive to disturbance. Furthermore, the ROP is based on planning principles which provide for the spatial and temporal coordination of construction projects in order to be able to reduce temporary factors affecting seabirds and resting birds, such as construction-related additional shipping traffic.

Even though similar factors would basically affect the protected asset seabirds and resting birds regardless of whether the ROP were implemented, it would be more difficult to ensure the protection of seabirds and resting birds if it were not implemented because of the lack of planning principles and their coordinating requirements.

3.2.6 Migratory birds

Construction-related: The main effects during the construction phase are light emissions and visual disturbance. These can cause species-specific, differently pronounced deterrent and barrier effects on migrating birds. However, lighting for construction equipment can also have the effect of attracting migrating birds and increase the risk of collision.

Installation- and operation-related: Possible impacts of offshore wind farms in the operational phase may be that they constitute a barrier to migrating birds or a risk of collision. Flying around or otherwise disturbing flight behaviour can lead to higher energy consumption, which can affect the fitness of the birds and subsequently their survival rate or breeding success. Bird strike events may occur on vertical structures (such as rotors and supporting 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; this can lead to birds becoming disoriented. Furthermore, birds caught in wake currents and air turbulence at the rotors could be adversely affected in their manoeuvrability. However, for the aforementioned factors, as for the deterrent and barrier effects, it can be assumed that the sensitivities and risks are different for each species.

In general, a threat to bird migration does not already exist if there is an abstract danger that individual birds may be harmed when passing through an offshore wind farm. A threat to bird migration only exists if there is sufficient evidence to justify the prediction that the number of potentially affected birds is such that, taking into account their respective population sizes, it can be assumed with sufficient probability that individual or several different populations will be significantly impaired. The biogeographic population of the migratory bird species in question is the reference point for the quantitative assessment.

There is agreement that, according to the existing legal situation, losses of individuals during bird migration must be accepted. In particular, it must be taken into consideration that bird migration in itself poses many dangers and subjects populations to harsh selection. Mortality rates can be around 60–80% in small birds; natural mortality rates are smaller in larger species. Individual species also have different reproductive rates; the loss of individuals can thus have different consequence for each species.

Because of a lack of sufficient knowledge, it has not yet been possible to determine a generally valid acceptance threshold.

For the assessment of a possible collision risk for migratory birds with wind turbines at sea, the relevant height parameters of the turbines are an important key figure. In the ROP, bandwidths for the height parameters of currently installed or potential turbine types were included according to the current technical developments of wind turbines (cf Chapter 4.2). This takes into consideration wind farm projects that are already in operation as well as those that will come into operation within the framework of the transitional system and the first commissioning years of the central system in zones 1 and 2. Another range of turbines represents systems which could potentially be installed in future wind farm projects in zones 3 to 5. For wind farm projects which have already been realised or future wind farm projects in zones 1 and 2, information or assumptions are available for 5 to 12 MW turbines which have 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 of 12 to 20 MW installations with 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 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.

Elevation profiles obtained via migration plan observations in areas EN1 to EN3 show a strong concentration on elevation ranges up to 20 m and thus below the rotor range of the turbines depicted above. While 85% of the birds recorded migrated in this altitudinal 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 20 m. 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 danger zone of the rotors (BIOCONSULT SH 2017).

Previous investigations of bird migration using vertical radar in the EEZ in the North Sea showed that there was a diurnal dependence in the altitudinal distribution. During the day, bird migration in spring was concentrated at lower altitudes because 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 were recorded at altitudes of 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, the height profiles of which 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. This suggests 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 of 9/10 November, bird migration was comparatively strongly shifted upwards. Avitec Research (2017) therefore assumes that its vertical radar system with its data availability up to 1,000 m altitude registers on average at least 2/3 of the total bird migration. In individual cases, depending on the vertical wind profile, the recorded proportion can be significantly higher during heavy bird migration. Conversely, more than half of all migratory birds will also be missed at nights with a distribution of altitude that only slowly decreases or even increases with altitude. However, this is usually the case only in a small number of nights.

Migrating birds generally fly higher in good weather than in bad. Moreover, most birds usually start their migration in good weather and are able to choose their departure conditions in such a way that they are reasonably likely to reach their destination in the best possible weather. In the clear weather conditions preferred by birds for their migration, the probability of a collision with WT is therefore low because the flight altitude of most birds will be above the range of the rotor blades and the installations are clearly visible. On the other hand, unexpected fog and rain, which lead to poor visibility and low flight altitudes, represent a potential risk situation. The coincidence of bad weather conditions with mass migration events is particularly problematic. According to information from various environmental impact studies, mass migration events, in which birds of a wide variety of species fly over the North Sea at the same time, occur about five to 10 times a year. An analysis of all existing bird migration investigations 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 poor weather conditions at less than 1% of the migration times (WELCKER 2019b).

In addition to the threat to bird migration from bird strikes, another risk to migrating birds can be seen in the fact 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, since much of the migration takes place at altitudes that are beyond the influence of wind turbines. Many songbirds migrate at altitudes between 1,000 and 2,000 m. Waders are also known to migrate at very high altitudes (JELLMANN 1989). However, significant proportions move at altitudes <200 m and thus within the sphere of influence of the 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 feed if necessary. For species like these, any detours are therefore only associated with minor impacts. It could be problematic for migrating land birds, which are not capable of landing on the water. It should be taken into consideration that migratory birds are capable of impressive non-stop flight performances, especially during the migration of non-aquatic species over seas. For example, the non-stop flight performance of many species, including small birds, exceeds 1,000 km (TULP et al. 1994). It is therefore unlikely that the additional energy requirement that may be required would jeopardize bird migration if a diversion was necessary in the North Sea EEZ, provided that no continuous barriers are created in the main direction of migration.

If the ROP were not implemented, there would be less spatial coordination in the planning of wind farm projects. This would probably increase land consumption. Furthermore, the ROP is based on planning principles which provide for spatial and temporal coordination of construction projects.

Even though similar factors would basically affect the protected asset migratory birds regardless of whether the ROP were implemented, it would be more difficult to ensure the protection of migratory birds if it were not implemented because of the lack of planning principles and their coordinating requirements.

3.2.7 Bats and bat migration

No reliable information is currently available about 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 affect bats:

Construction-related: Construction activities during the erection of WT* are associated with an increased volume of shipping. The lighting of the ships and the construction site can have an attracting effect on bats migrating across the sea. There would then be a risk of collision with the ships and the construction site.

Installation and operational: During the operating phase, the illumination of the installations may cause attraction effects that could lead to collisions.

If the plan were not implemented, the same impacts on bats may occur as if the plan is implemented.

3.2.8 Air

The construction and operation of the wind turbines and platforms and the laying of undersea cable systems will increase the amount of shipping traffic. However, there are no measurable effects on air quality. The protected asset air will therefore develop in the same way regardless of whether the plan is implemented.

3.2.9 Climate

Negative impacts on the climate from offshore wind energy are not expected, since there are no measurable climate-related emissions 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 positive impacts on the climate in the long term.

3.2.10 Landscape

The realisation of offshore wind farms has impacts on the landscape because it is altered by the installation of vertical structures. The installations also have to be fired at night or when visibility is poor for safety reasons. This can also lead to visual impairments of the landscape. The construction of platforms can also lead to visual changes in the landscape. The extent to which the landscape is adversely affected by offshore installations is strongly dependent on the respective visibility conditions as well as 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 partly also as technically interesting. In any case, they cause a change in the landscape, and the character of the area is modified. The actual visibility of the offshore wind farms is determined by the distance thereof from the coast or islands, the size of the wind farm in terms of area, the height of the wind turbines, the visibility range based on the specific weather conditions, the height of the observer's location (e.g. beach, viewing platform, lighthouse) and the performance of the human eye. Due to the considerable distance (more than 30 km) between the WTGs and platforms which are planned and have already been installed and the coast, the turbines will only be visible from land to a very limited extent and only in good visibility conditions. This also applies with regard to night-time safety lighting.

To minimise visibility, a glare-free and low-reflection coating is a standard requirement for the approval of individual projects. It must also be taken into consideration that the platforms are always in close proximity to the offshore wind farms, so that the change in the landscape appearance is only slightly increased by these individual structures in the immediate vicinity of the offshore wind farms.

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 requirements can be minimized by the provisions of the ROP (and the land development plan). The potential impacts on the landscape as a protected asset can therefore be reduced to a minimum by means of geographically coordinated, anticipatory and coordinated overall planning of the ROP and the FEP. Insufficient geographic coordination in the event of non-implementation of the plan could lead to more fragmented wind farm areas, the use of more land and a slight increase in visibility from the coast.

For the submarine cable systems, negative impacts on the landscape during the operational phase can be ruled out because of the laying as underwater cables.

3.2.11 Cultural assets and other material assets

The deep foundations of wind turbines result in disturbances to the seabed due to construction, which can affect discovered and undiscovered cultural heritage. The cultural heritage is completely or partially destroyed or its context adversely affected during excavation or pile driving. In addition, extensive secondary impacts on the protected asset underwater cultural heritage site caused by construction vehicles are to be expected during construction work.

Because the foundation acts 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 spatial plan include pipelines and submarine cables. Submarine cables include cross-border power cables and connecting cables for offshore wind farms as well as data cables. Farm-internal submarine cables are not included in this definition. In this respect, reference is made to the designations within the framework of the sectoral planning (SDP).

The North Sea EEZs are crossed by pipelines which only cross the German continental shelf (so-called transit pipelines) and those which also go ashore on the German coast. The Norpipe, Eu-ropipe 1 and Europipe 2 pipelines transport gas from the Norwegian gas fields to Germany. These pipelines go ashore on the coast of Lower Saxony. Since 2009, a gas pipeline between the Danish Ravn oil field and the German production platform A6-A has been added in the Duck's Bill area. No further pipelines are currently planned.

The reservation areas for lines serve to secure routes for existing and future pipelines and submarine cables. Current-carrying cables are the subject of specialist planning.

Nine undersea cable systems are currently in operation in the North Sea EEZ for connecting offshore wind farms. Five more systems are currently under construction.

In the North Sea, grid connection systems are operated with direct 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 transferred from the transformer platform via an AC cable (alternating current) to the transmission system operator's converter platform. Alternatively, in the future the wind turbines will have a direct connection to the converter platform by means of a 66 kV undersea cable system. The 66 kV direct connection was defined as a standard connection concept in the FEP 2019.

In comparison, the DC transmission technology is more area-efficient due to the significantly higher transmission capacity compared to AC technology, combined with fewer environmental impacts caused by cable laying.

Three transnational power cables, NorNed, Nord.Link and COBRAcable, are currently also operating in the North Sea EEZ. Large numbers of transnational data cables - usually fibre optic cables for telecommunications - cross the German North Sea. 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 assets seabed, benthos, and fish; here, the potential impacts resulting from the introduction of hard substrate, turbidity plumes and, for current-carrying cables, operation-related heat emissions and possibly magnetic fields are assessed.

For the assessment of the designations for lines, the following possible impacts are assessed:

Table 17: Potential impacts of pipelines on the marine environment (t = temporary).

Use	Effect	Potential impact	Protected assets																
			Benthos	Fish	Seabirds and rest-	Migratory birds	Marine Mammals	Bats	Plankton	Biotopes	Biological diversity	Seabed	Site	Water	Air	Climate	Human/ Health	Cultural and mate-	Landscape
Lines Routes for submarine cable systems and pipelines	Placement of hard substrate (stone pile)	Modification of habitats	x	x					x	x		x						x	
		Habitat and land loss	x	x						x		x	x					x	
	Heat emissions (live cables)	Adverse effects on/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 deterrent effects		x t															

3.3.1 Seabed

Pipelines

The formation of a turbidity plume near the seabed and minor changes to the morphology and sedimentary composition are likely during laying in the seabed. The resuspended sediments are transported and deposited by different distances in the vicinity of the pipeline depending on the grain size: The distances are significantly less than those determined for the sedimentation of turbidity plumes during the course of sand and gravel extraction. The concentrations of resuspended particulate material are of comparable magnitude to natural resuspension of sediments caused by storms.

The formation of undercuts ("freespans") can lead to a change in the sedimentary composition or grain composition. However, this is geographically limited. Depending on the sand supply and geological structure of the subseabed, this undercutting can stabilise or occur only intermittently. In the case of sand deficits, the substrate may change, e.g. due to the temporary presence of till, clay or the like on the seabed.

To protect the pipeline from external corrosion, sacrificial anodes made of zinc and aluminium are attached at regular intervals. These anodes are dissolved only in small quantities and released into the water column. Because of the very high dilution, they are present only in trace concentrations; in the water, they are adsorbed to sinking or resuspended sediment particles and sediment on the seabed.

Submarine cable

When undersea cables are being laid, changes to the soil morphology and the original sediment structure generally occur in the route area as a result of the cable laying. However the seabed along the affected routes can regenerate because of the natural sediment dynamics in the North Sea.

In addition to the formation of a ground-level turbidity plume, the re-suspension of sediment-bound pollutants and increased pollutant introduction by construction site traffic can occur.

Magnetic effects during the operation of current-carrying cables can be neglected or ruled out because the magnetic fields in alternating current cables (three-wire three-phase cables) and bipolar direct current cables almost cancel each other out. Depending on the duration and strength of the wind speed, energy is lost during the transfer of power to the land-based grid, which leads to heating of the sediment around the cable. In accordance with the state of the art, no oil-insulated cables are used. Lead cannot escape through the insulation.

Operation-related Both direct current and three-phase undersea cable systems heat up the surrounding sediment radially around the 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: Basically, greater heat emission due to thermal losses can be assumed with three-phase submarine cable systems than with direct current submarine cable systems with the same transmission capacity (OSPAR Commission 2010).
- Ambient temperature in the vicinity of the cable systems: Depending on the water depth and the time of year, fluctuation of the natural sediment temperature can be assumed, which influences heat dissipation.
- Thermal resistance of the sediment: Mainly water-saturated sands occur in the EEZ, for whose specific thermal resistance a size 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, more efficient heat removal can be assumed for water-saturated coarse sands than for finer-grained sands.

For the temperature development in the sediment layer near the surface, the installation depth of the cable systems is also decisive. According to the current state of knowledge, no significant impacts from cable-induced sediment warming are to be expected if sufficient installation depth is maintained and state-of-the-art cable configurations are used. Various calculations relating to sediment heating caused by the operation of undersea cable systems were presented within the scope of environmental technical papers on the subject of the current-carrying cable systems of offshore wind farms. According to the applicant, the cable-induced sediment warming for the "BorWin 3 and BorWin gamma" project will amount to approx. 1.3 K at a 20 cm sediment depth for the DC cables if the cables are flushed to a depth of at least 1.50 m as specified in the SDP (PRYSMIAN, 2016). Temperature measurements on a park-internal rotary current cable system in the Danish offshore wind farm "Nysted" showed a sediment warming 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 water movement near the bottom of the North Sea also leads to the rapid removal of local heat.

Taking into consideration the aforementioned results and forecasts, it can be assumed that with a laying depth of at least 1.50 m, compliance with the "2 K criterion"[10] can be assumed. This has established itself 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 warming has already been included in the BFO-N and continued in the SDP (cf planning principles 5.3.2.9, 5.4.2.9, and 5.5.2.13 BFO-N as well as planning principle 4.4.4.8).

This principle defines the compliance with the 2 K criterion in order to reduce potential adverse effects on the marine environment from cable-induced sediment warming as far as possible. If the 2C criterion is adhered to in accordance with the planning principle, as things stand it can be assumed that no significant impacts, such as structural and functional changes, can be expected from cable-induced sediment heating on the seabed as a protected resource. Due to the low proportion of organic material in the sediment, no significant release of pollutants is expected from sediment heating.

The above-mentioned impacts on the soil as a protected resource occur independently of the stipulations of the ROP. If the plan is not implemented, however, geographically less coordinated planning of the pipe systems would have to be expected. This would result in an increased number of line crossings or crossing structures, which would require the introduction of hard substrate.

Since the provisions of the plan are aimed at minimising the use of the seabed/ sensitive areas due to the predominant location outside of sensitive areas and the reduction of pipeline routes, it is likely to be more difficult to ensure soil protection if the plan is not implemented than if the plan is implemented.

[10] "The 2 K criterion represents a precautionary value that, according to the assessment of the BfN, ensures with sufficient probability, based on the current state of knowledge, that significant negative impacts of cable warming 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 biotopes

With regard to benthos and biotopes, the explanations in Chapter 3.2.2 apply analogously. If the plan is not implemented, pipeline planning that is less geographically coordinated would have to be expected. The pipelines mainly run outside sensitive protected areas. In addition, an increased number of line crossings or crossing constructions would have to be expected; this 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.

Since the provisions of the plan are aimed at minimising the use of the seabed/ sensitive areas due to 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 than if the plan were not implemented.

3.3.3 Fish

Pipelines

During the construction phase of pipelines, the fish fauna can be temporarily disturbed by **noise and vibrations** both through the use of ships and cranes and through 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 redistribution can take place; this can harm fish, especially spawn and larvae. The ecological impacts of turbidity plumes on fish are described in detail in Chapter 3.4.3. The effects on fish in areas with sediment redistribution are short-term and geographically limited.

Submarine cable

The construction-related adverse effects on fish fauna from submarine cables as well as from pipelines are to be expected from **noise emissions and turbidity plumes** . Detailed information can be found in Chapters 3.2.3 and 3.4.3 .

A **local change in** the **fish community** is to be expected as a result of the stone packing in the area of the planned line crossings. A change in the fish population can lead to a change in dominance ratios and the food web. However, these effects are to be regarded as minor due to the small-scale nature of the planned cable crossings.

With regard to the possible operational impacts of the submarine cable systems of OWF such as **sediment warming and electromagnetic fields**, no significant impacts on fish fauna are expected. 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 type of cable due to the shielding. Induced magnetic fields of the individual conductors largely cancel each other out in the planned bundled installation (with one outgoing and one return conductor) and are significantly below the strength of the earth's natural magnetic field. According to TdV, the magnetic field generated during operation of the Ostwind 2 cable system is a maximum of 20 μT at the seabed surface. In comparison, the natural geomagnetic field of the earth 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 be sensitive to electromagnetic fields. However, various studies on the effects of electromagnetic fields on the European eel did not show clear results. In the Danish wind farm "Nysted", no behavioural changes of the eel were surveyed (BIO/CONSULT AS 2004). However, both WESTERBERG AND LAGENFELT (2008) and GILL AND BARTLETT (2010) recorded short-term changes in their swimming activity. Overall, because of the expected moderate and small-scale change in the magnetic field in the area of the cable, a blockade of the migratory movements of marine fish is unlikely. However, magnetosensitive fish species could avoid the immediate vicinity of the cable.

For the three-wire three-phase cables and bipolar DC cables envisaged in the German EEZ, magnetic effects during operation can be neglected or excluded because the magnetic fields nearly cancel each other out. No significant effects on sensitive fish species are therefore to be expected.

The objectives and principles for pipelines in the ROP take into consideration the gentlest possible cable laying procedure, the bundling of lines, and optimised routing. The impacts on fish fauna is thus expected to be minimised; this would not be the case if the plan were not implemented.

3.3.4 Marine mammals

Pipelines

The laying, operation, maintenance and dismantling of pipelines in the sea can have an impact on marine mammals. To be mentioned are: shipping traffic, noise emissions, sediment plumes, and pollution. During normal operation, impacts on marine mammals can be ruled out with a high degree of certainty. During maintenance work, increased shipping traffic with noise emissions and pollution is possible.

Construction-related: When pipelines are laid, temporary noise pollution and sediment turbidity plumes occur. The intensity and duration of the noise emissions depends essentially on the cable laying procedure. Overall, however, disturbance to marine mammals from laying works is small-scale, local, and of short duration.

Impacts resulting from alteration of sediment structure and damage to benthos during relocation are, in any case, negligible for marine mammals. These changes take place on a small scale along the pipeline. Impacts resulting from long-term changes in sediment structure and benthos are insignificant for marine mammals because they forage for their prey organisms predominantly 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 especially from noise emissions during pipe-laying work are to be expected only regionally and for a limited period of time. The formation of sediment plumes is largely expected to be local and temporary. A habitat loss for marine mammals at the individual level could thus occur overall at most locally and for a limited period of time.

Operational reasons: 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 do not have significant impacts on marine mammals. In the event of damage to the pipeline or inspection and maintenance work being carried out, regional and temporary disruptions due to shipping traffic with noise emissions and pollutant leakage are possible.

Impacts from sediment and benthic changes are insignificant for marine mammals because they forage for their prey organisms predominantly in the water column in widespread areas. If the benthic species spectrum were to change along pipelines laid on the seabed, the change may attract fish to a greater extent. Increased fish occurrence could in turn attract marine mammals.

During normal operation, the effects on the population level are not known. Due to the narrow, linear shape of pipelines, negative effects on the population level can be excluded with certainty.

The non-implementation of the plan would not affect the existing or described effects of pipelines on harbour porpoises, harbour seals and grey seals.

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. Possible 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 in question.

Construction-related: The laying of cables causes temporary noise emissions that may cause disturbance to marine mammals. The duration and intensity of the sound emissions vary depending on the installation method. However, the effects of noise emissions during installation are local and temporary. The intensity of the effects may vary between medium and high, depending on the method of installation. This also applies to effects due to the formation of turbidity plumes. Changes in sediment structure and associated temporary changes in benthos have no effect on marine mammals. Marine mammals seek their prey in extensive areas in the water column.

Operational reasons: During operation, power cables can lead to heating of the surrounding sediments. However, this has no direct effect on highly mobile animals such as marine mammals.

Overall, no significant impacts on marine mammals are expected from cables used to dissipate energy or from bundling cables in a common route – either at individual or population level.

The non-implementation of the plan would not affect the existing or described effects of undersea cables on harbour porpoises, seals and grey seals.

3.3.5 Seabirds and resting birds

Pipelines

Constructional*:* When pipelines are laid, temporary sediment turbidity plumes and local sediment and benthic changes occur. During the laying work, the construction-related shipping traffic can cause visual disturbance and trigger deterrent or avoidance reactions in disturbance-sensitive species.

Overall, potential construction-related impacts are only temporary and local for the duration and immediate area of the relocation.

Operational reasons: Impacts resulting from sediment and benthic changes are of minor importance for seabirds and resting birds because they forage for their prey organisms predominantly in the water column in widespread areas. If the benthic species spectrum were to change along pipelines laid on the seabed, the change may attract fish to a greater extent. Increased fish occurrence could in turn also attract seabirds. During the operational phase, maintenance-related shipping traffic can cause visual disturbance and trigger temporary deterrent or avoidance reactions in disturbance-sensitive species.

Submarine cable

Constructional*:* During the laying of submarine cables, temporary sediment turbidity plumes and local sediment and benthic changes occur. During the laying work, the construction-related shipping traffic can cause visual disturbance and trigger deterrent or avoidance reactions in disturbance-sensitive species.

Overall, potential construction-related impacts are only temporary and local for the duration and immediate area of the relocation.

Operational reasons: Impacts resulting from sediment and benthic changes are of minor importance for seabirds and resting birds because they forage for their prey organisms predominantly in the water column in widespread areas. During the operational phase, maintenance-related shipping traffic can cause visual disturbance and trigger temporary deterrent or avoidance reactions in disturbance-sensitive species.

If the plan were not implemented, there would be less spatially coordinated planning of lines and gates. 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 the marine environment and thus also seabirds and resting birds.

Even though similar factors would basically affect the protected asset seabirds and resting birds regardless of whether the ROP were implemented, it would be more difficult to ensure the protection of the marine environment and thus seabirds and resting birds if it were not implemented because of the lack of planning principles and their coordinating requirements.

3.3.6 Migratory birds

Pipelines

Potential impacts of pipelines on migratory birds are limited mainly to the construction phase. Illuminated construction vehicles can cause attracting effects, which can lead to collisions.

Submarine cable

Potential impacts of pipelines on migratory birds are limited mainly to the construction phase. Illuminated construction vehicles can cause attracting effects, which can lead to collisions.

The potential impact on bats is independent of the non-implementation or implementation of the plan.

3.3.7 Bats and bat migration

Potential impacts of lines and bats are limited mainly to the construction phase. Illuminated construction vehicles can cause attracting effects, which can lead to collisions.

The potential impact on bats is independent of the non-implementation or implementation of the plan.

3.3.8 Air

Pipelines

The laying, maintenance and dismantling of pipelines involves shipping traffic. This in turn leads to pollutant emissions which can affect air quality.

Significant adverse impacts on air quality are not expected.

Submarine cable

The laying, maintenance and dismantling of underwater cables involves shipping traffic. This in turn leads to pollutant emissions which 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 the underwater cultural heritage depend on the laying procedure used. Both flushing and dredging can lead to the destruction of underwater cultural heritage on the seabed. In addition to the direct effects of the cable laying procedure used, indirect impacts (e.g. because of 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 operational impacts are not to be expected.

3.4 Raw material extraction

Extraction of raw materials from the sea takes place for both commercial purposes and – especially stone, gravel, and sand extraction – for coastal protection. In addition, large sites, 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 thereof is particularly evident as far as the North Sea is concerned, where production at sea clearly exceeds that 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 Section 48, paragraph 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 adversely affected as little as possible. Furthermore, in Sections 48 ff, the BBergG specifies regulations for the benefit of shipping, fishing, the laying and operation of cables and pipelines, and the marine environment. These must be observed when exploring for or approving operating plans for an operation in the area of the continental shelf.

According to Section 7 BBergG, permits grant the authorised permit holder the exclusive right to explore for mineral resources in a specific field. According to Section 8 BBergG, permits grant in particular the exclusive right to extract a raw material. The refusal of the permit or authorisation shall be based on the existence of the grounds specified in Section 11 or Section 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 Section 4, paragraph 1 BBergG. It is carried out regularly in the marine area through geophysical investigations, including seismic surveys and exploratory drilling. In the EEZ, the extraction of raw materials includes the extraction (loosening, release), 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 specified field for a specified period of time. Additional approvals 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 shall be drawn up for a period not exceeding 2 years as a rule and shall be continuously renewed as required (Section 52, paragraph 1, sentence 1 BBergG).

In the case of mining projects requiring an UVPG, the preparation of an outline operating plan is obligatory; for the approval of this, a planning approval procedure must be carried out (Section 52, paragraph 2a BBergG). Framework operating plans are usually 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 according to Section 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 from 2004 to 2009, mining permits for sand and gravel extraction in the Sylt outer reef area were available for the North Sea as follows:

Authorisation field	Weisse Bank	until 2039
Authorisation field	BSK 1	until 2033
Authorisation field	OAM III	until 2051

In these areas, between 0.8 and 2.4 million tonnes of sand and gravel were mined each year from 1997 to 2006 using valid framework operating plans.

Hydrocarbon exploration permits (NE3-0001-01 until the end of May 2022; NE3-0005-01 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).

For the extraction of natural gas in the "Duck's Bill" at the border with the Danish EEZ, a German North Sea A6/B4 permit (until 2028) is available. 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

From 2009 to 2021, there has been an approval of a new hydrocarbon permit field in the German EEZ of the North Sea (NE3-0002-01, since December 2010).

For the German EEZ in the North Sea, a decrease in the area of hydrocarbon permit areas has been observed since the adoption of the 2009 spatial development plans.

All the fields of approval for hydrocarbons in the Duck's Bill have expired, with the exception of the German North Sea A6/B4 permit with the A6-A production platform. The permit for mining in the Weisse Bank field has expired (ruling of the Schleswig Higher Administrative Court, legally effective since 12 February 2019). Since 2009 there has been no general operating plan for the BSK1 field.

The following table shows the effects of raw material extraction and potential impacts on the protected assets.

Table 18: Effects and potential impacts of raw material extraction

Use	Effect	Potential impact	Protected assets																
			Benthos	Fish	Seabirds and resting birds	Migratory birds	Marine Mammals	Bats	Plankton	Biotopes	Biological diversity	Seabed	Site	Water	Air	Climate	Human/ Health	Cultural and material assets	Landscape
Raw materials Sand and gravel mining/Seismic investigations	Removal of substrates	Modification of habitats	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 deterrent effects		x t															
	Physical disturbance	Adverse effect on the seabed	x							x		x	x						
	Underwater sound during seismic surveys	Adverse effect/deterrent effect		x t			x t												

Potential temporary impacts result from underwater noise during seismic investigations and from turbidity plumes during raw material extraction and may lead to adverse effects and deterrent effects. Potential permanent impacts from substrate removal and physical disturbance causing habitat and area loss, habitat modification, and adverse effects on the seabed.

3.4.1 Seabed

Sand and gravel extraction

In the North Sea EEZ, the extraction of gravel and sand is carried out over a large area with a suction trailer hopper dredger. For technical and navigational reasons, a suction trailer hopper dredger with a towing head which is usually 2 m wide passes over the extraction field several times until the maximum permissible extraction depth of 2 m is reached with an additional dredging tolerance of approx. half a metre. As a rule, approximately 2 to 4 m wide furrows with a maximum depth of 2.6 m are created, between which unaffected seabed remains. A residual thickness of the pumpable sediment must be maintained in order to preserve the original substrate for repopulation.

Stone fields are excluded from extraction at 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.

During these sediment dredging operations, the seabed as a protected resource is affected in many ways:

- Substrate removal and change of seabed topography
- Change in hydrographic conditions
- formation of turbidity plumes & sedimentation of suspended material
- Remobilisation of pollutants

Substrate removal and change as well as change in seabed topography: Due to the mining technique described above, the seabed is not evenly deepened by 2.6 m over the entire area, but a relief consisting of multiple crossing furrows and original seabed is created. This topographical or morphological change is accompanied by an influence on the near-bottom flow pattern. In principle, the original substrate is to be preserved by surface quarrying provided that the thickness of the quarryable sands, gravel sands, and gravels is sufficient. Selective extraction ("screening") results in a change to the substrate; depending on the returned fraction, the original sediment type is refined or coarsened. Whereas the gravel fraction is locally stable and does not undergo any significant rearrangement, the returned sand is mobilised by the natural sediment dynamics. Because of the altered topography, the furrows have a trapping effect in which relocated, usually finer-grained sand accumulates and permanently alters 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):

- Because of the mechanical disturbance of the sediment in the seabed by the dredge head
- The overflow water flowing back into the sea from the dredger
- The dumping of unwanted sediment fractions (screening).

The concentration of suspended material usually decreases very rapidly with removal (HERRMANN AND KRAUSE, 2000). However, increased turbidity is observed up to a distance of few hundred metres from the excavator, and in some cases can even be detected several kilometres away. The extent of the turbidity plume depends on the grain size and quantity of the returned material as well as the flow and its directional stability. Depending on the grain size and water depth, sorting of the returned grain mixture takes place: the coarse particles are deposited first, most of which are 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 experiences 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 introduction is negligible, since commercially used sands and gravels generally have a low content of organic and clayey components and therefore hardly any chemical interaction with the water column. The extraction activities are also temporally and geographically limited.

Sand and gravel extraction is currently carried out within the framework of locally adapted conditions (ancillary provisions in the main operating plan) exclusively in extraction area OAM III on a currently applied for extraction area of 17.5 km² (real space requirements: 5.3 km²). With regard to the biotope of “Species-rich gravel, coarse sand, and shingle grounds” occurring in this area, monitoring investigations showed that the extraction activities to date have not led to any fundamental change in the sediment structure or composition in the extraction area. The original substrate in the site was preserved, and the results show occurrences of this protected biotope in the same location within the extraction area (IFAÖ 2019a); the BfN also confirms this in its comment. . In the event of changes in mining activities, the following must be ensured (OAM III Main Operating Plan,2019):

- There are still a sufficient number of intact areas between the excavation tracks, so that the potential for re-colonisation with typical species-rich gravel, coarse sand and sediments is still demonstrably present,
- 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 sediments, is demonstrably retained.

With regard to the survey of changes in the original substrate, in the case of the BSKI and OAM III permit fields, the highly variable small-scale occurrence of gravel and coarse sand areas as well as stones and boulders in the nature conservation area “Sylt Outer Reef - Eastern German Bight” (see Chapter 2.1.1 and Figure 15) must be taken into consideration.

Based on the findings to date from the OAM III permit field, it can be summarised that the protection or conservation of original substrate and protected biotopes in the course of sand and gravel extraction is possible, among other things, by means of locally adapted ancillary provisions and suitable monitoring investigations.

Extraction of hydrocarbons

In the German EEZ, the "A6-A" production platform for the production of natural gas has been in operation since September 2000. The platform is located at a water depth of 48 m. It is a six-legged, lattice-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[11] drilling and production platform, the following impacts on the protected asset seabed are to be expected:

Construction-related: Effects can occur due to load-induced compaction and material changes in the sediments during the . During the introduction of cuttings/drilling fluid, temporary turbidity can occur.

System-related: Effects may occur in the form of foundation-related compaction of the seabed, pollution caused by coatings and changes to the flow conditions via the platform.

Operational: Corrosion coatings, sheathing materials and sacrificial anodes used for corrosion protection may release harmful substances. The discharge of production water and effluent from the treatment plant can lead to impacts on water and sediment.

In addition, long-term settlement of the seabed of the order of several metres is to be expected as a consequence of the extraction of natural gas deposits; this 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 extraction in Area KWN1, there are still the permit fields NE3-0002-01 at the border to the Dutch EEZ and NE3-

[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 from 22 March 1999 – 21 – 23/98 VI- W 60004 Bh. 29 – III -

0001-01 and NE3-0005-01 north of Borkum Riffgrund. Within the licence fields, new licences for gas production are expected to be issued in the future. By defining the KWN2-KWN5 reserved areas, areas for the construction of an infrastructure associated with the production area specified within the large-scale approval fields. This will allow, for example, better spatial control of the locations of production platforms. Impacts on the seabed protected resource - as described above for the example of the A6-A production platform - can therefore be controlled and minimised.

The current sand, gravel and hydrocarbon extraction in the German North Sea is already technically secured by the competent authority. The effects described above would therefore still exist even if the plan were not implemented. However, the establishment of reserved areas will result in a greater geographical concentration of the use of raw material extraction and will be given greater importance in regional planning considerations in the future. The seabed protected resource is therefore more likely to be affected in the reserved areas if the plan is implemented than if it is not.

3.4.2 Benthos and biotopes

The following comments are limited to the effects of the uses on benthic communities. Because biotopes are the habitats of a regularly recurring community of species, adverse effects of biotopes have direct impacts on biotic communities.

Sand and gravel extraction

A number of physical and chemical impacts of sediment dredging (HERMANN and KRAUSE, 2000) are possible; these are also relevant for the marine benthos:

(a) Substrate removal and changes to soil topography. The most serious ecological impact of sand and gravel extraction is the reduction of the infauna and epifauna. The aspects of settlement density and biomass of benthic organisms are usually more affected than those of species numbers. In Dutch investigations 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%. The regeneration of the benthic fauna can take periods ranging from one month to 15 years or more depending on the intensity and duration of the change in environmental conditions and sediment character as well as the spatial distance for immigrating species (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 prior to degradation (predominantly opportunistic species); species and individual numbers increase rapidly and can sometimes reach baseline levels after a short time; however, biomass remains low.
- *Phase II*: The biomass remains significantly reduced over a longer period (several months to years). This may be caused by the loss of the older age groups of long-lived species (e.g. bivalves such as *Mya arenaria, Cerastoderma* spp. and *Macoma balthica*) or the impediment of recolonisation by the continued rearrangement of sediments disturbed by extraction.
- *Phase III*: The biomass increases significantly, and the cenoses regenerate completely.

  Very long-lasting changes in benthic communities are observed in mining areas where another sediment remains after dredging.

The result is a permanent change in the seabed fauna, often towards soft seabed communities (HYGUM, 1993 cited in HERRMANN and KRAUSE, 2000). In certain cases, a permanent change from soft to hard seabeds with corresponding faunal change may also occur (HERRMANN and KRAUSE, 2000). In accordance with 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 conservation area “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 biotopes and, in particular, of species-rich gravel, coarse sand, and shell layers. At present, there is no evidence that the previous extraction activities have led to a fundamental change in the sediment structure or composition in the extraction area. There are no statistically significant differences to the abundance and species composition of macrozoobenthos in the extraction and reference areas. As expected, only the total biomasses are statistically significantly lower in the extraction area than in the reference area (IFAÖ 2019a). Overall, the investigations show that the original substrate was preserved in the area and that there is a regenerative capacity, especially for species-rich gravel, coarse sand, and shingle seabeds*. A change to the geographical expansion of the species-rich gravel, coarse sand and sediments due to previous mining activities is not to be expected, since there has been no loss of coarse sand areas and character species. The temporary losses of the benthos in the extraction area are compensated for within a relatively short period of time as a result of the recolonisation of the area with a comparable species community so that no permanent adverse effects of the extraction areas are caused (IFAÖ 2019a).

In the incidental provisions of the main operating plan OAM III of 3 December 2019, it was also stipulated that a "Steinfeld/Blockfeld North Sea" defined by the Federal Agency for Nature Conservation (BfN, 2018) in accordance with the Reef Mapping Instructions (BfN, 2018) is excluded from extraction and that "marine boulders" within a radius of 75 m are not affected. It was also determined that sufficient areas that have not yet been excavated remain between the excavation tracks so that the potential for recolonisation with typical species-rich gravel, coarse sand and sediments continues to exist and the original substrate is preserved. Appropriate measures must also be taken for future main operating plans in the SKN1 and SKN2 areas.

(b) changes to hydrographic conditions. The change in seabed topography can cause changes in hydrographic conditions and thus also in water exchange and sediment transport. As a result of changes in bathymetry, a decrease in current velocity may occur locally, therby leading to deposition of fine sediments and local oxygen deficiencies (NORDEN ANDERSEN et al., 1992). This can have consequences for the seabed fauna. According to GOSSELCK et al. (1996), although sand and gravel extraction is not expected to have impacts on large-scale flow conditions, small- and meso-scale changes must be considered.

(c) turbidity plumes*.* Turbidity plumes can essentially arise at three points in the degradation process (HERRMANN und KRAUSE, 2000):

- Because of the mechanical disturbance of the sediment in the seabed by the dredge head
- The overflow water flowing back into the sea from the dredger
- The dumping of unwanted sediment fractions (screening).

Although increased turbidity can be observed up to several hundred metres away from the dredger 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 substances does not appear to be harmful to adult mussels. The growth of filter-feeding mussels can even be promoted. However, eggs and larvae of a species generally react more sensitively than the adults.

Although the concentration of suspended particles can reach levels that are harmful to certain organisms, the impacts on marine organisms are considered to be relatively low because 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; the highest concentrations were recorded 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.

Chemical impacts are generally considered to be relatively low because commercially used sands and gravels generally have a low content of organic and clayey components and therefore hardly any chemical interrelationships with the water column. Furthermore, the mining activities are limited in time and space. Waves and currents also cause rapid dilution of any increases in the concentration of nutrients and pollutants that may occur (ICES, 1992; ICES WGEXT, 1998).

(e) sedimentation and sanding: The dispersion of sediment particles depends to a large extent on the content of fine particles and the hydrographic situation (especially sea state, current) (HERRMANN and KRAUSE, 2000). In some cases, drifting of suspended particles was detected 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, investigations 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 phenomena and adverse developmental effects on benthic organisms.

The practice of "screening" (dumping of unwanted sediment fractions) can also lead to a change in the soil substrate towards mobile sandy areas. The effects of sediment fallout from the overflow of ships on the benthic communities of areas not directly affected by dredging can vary greatly. The following possibilities have been observed in previous studies (ICES 1992):

- Initially, as in the dredging area, there is an almost complete die-off of the benthic fauna; however, 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 can 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 effects of sand and gravel extraction on 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 because of 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 the remobilisation of chemical substances.
- Temporary (short-term) and regional (small-scale) impairments of development, possibly also loss of individuals of benthic organisms due to sedimentation and overlying sand.

Indirect effects:

- Temporary (short-term) and regional (small-scale) loss of settlement habitat for benthic organisms because of substrate removal if sediment character is not altered by dredging.
- Permanent and regional (local) loss of settlement space because of possible changes in hydrographic conditions.
- Temporary (short-term) and regional (small-scale) influence on the food supply for benthic organisms through adverse effects on primary production (phyto- and zooplankton) because of the remobilisation of chemical substances.

Extraction of hydrocarbons

The conceivable impairments to benthic communities by offshore platforms for the production of natural gas can be divided into three areas. These include the construction- and plant-related and the operation-related effects.

The construction and installation-related impacts can largely be found in Chapter 3.2.2 on offshore wind energy.

By way of a summary, the main impacts of natural gas production on marine benthos are as follows:

Direct effects:

- Small-scale and short-term habitat loss for the duration of the installation of the foundations due to sediment turbulence 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 habitat lost due to the pillars of the platform because of land use.
- Small-scale and permanent supply of artificial hard substrate due to the construction of the platform.
- Small-scale and permanent changes to sediment parameters due to the design of the platform.

Indirect effects:

Short-term and small-scale influence on the food supply for benthic organisms through adverse effects on primary production (phyto- and zooplankton) because of the possible remobilisation of chemical substances.

3.4.3 Fish

Sand and gravel extraction

The extraction of sand and gravel in the North Sea can change habitats and mean a loss of habitat for the fish population. In addition, substrate removal results in turbidity plumes with associated sedimentation and resuspension of sediment particles; these can affect fish fauna.

During the removal of substrates, the fish are usually scared away from their habitat. A **loss of area** depends on the geological nature of the material removed. 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 the case only for a few species in the EEZ of the North Sea such as the sand eel (HERRMANN & KRAUSE 2000). Sand eels use sandbanks as habitat, overwintering, and spawning areas (IFAÖ 2019a). Sand eels burrow into sediments and lay their eggs there. As a result of this way of life, no representative findings on densities and population sizes in the sand and gravel extraction area were made during investigations in 2002 and 2010 (IFAÖ 2019a). A materiality assessment* of the impacts of raw material extraction can therefore not be made.

It should be noted that a habitat loss for sand eels, which are a main food source for harbour porpoises, grey seals, and various seabird species, could also affect other protected assets via the food web. Associations between the abundance of sand eels and the breeding success of birds have been demonstrated for kittiwakes, for example (MACDONALD et al. 2019). Fish themselves are also indirectly adversely affected by the loss of food resources because sand and gravel extraction is associated with a reduction in the invertebrate infauna and epifauna in the area.

Sand and gravel extraction also creates **sediment turbulence and turbidity plumes**; although these are temporary and species-specific, they can also cause adverse physiological effects as well as scaring away. Predators that hunt in open water (e.g. mackerel and horse mackerel) avoid areas with high sediment loads and thus avoid the danger of gill adhesion (EHRICH & STRANSKY 1999).

A threat to these species as a result of sediment turbulence does not appear likely because of their high mobility. Neither is any impairment of bottom-dwelling fish to be expected due to their good swimming properties and the associated evasion possibilities. Plaices and sole were even found to have increased foraging activity after storm-induced sediment turbulence (EHRICH et al. 1998).

In principle, however, fish can avoid disturbances thanks to their distinct sensory abilities (lateral line organ) and their high mobility; adverse effects are thus unlikely for adult fish. Eggs and larvae, in which reception, processing, and conversion of sensory stimuli are not yet or only slightly developed, are generally more sensitive than adult conspecifics. After fertilisation, fish eggs develop a leather skin 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 impacts on fish are considered to be relatively low because 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 the concentration of nutrients and pollutants resulting from the **resuspension of** sediment particles (ICES 1992; ICES WGEXT 1998). 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 & 2000). For the North

Sea, chemical impacts are generally considered to be relatively low because commercially used sands and gravels generally have a low content of organic and clayey components and therefore hardly any chemical interrelationships with the water column.
With **sedimentation** of the released substrate, the main risk is coverage of fish spawn deposited on the seabed. This can result in an undersupply of oxygen to the eggs and, depending on the degree of effect and duration, can lead to damage or even death of the spawn. For most fish species occurring in the EEZ, spawning damage is not expected because 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 occurs in the North Sea due to natural phenomena such as storms or currents.

The aforementioned impacts of sand and gravel extraction on fish fauna occur regardless of the non-implementation or implementation of the plan.

Extraction of hydrocarbons

Extraction platforms are built for the extraction of hydrocarbons, which can affect the fish community during the construction and operation phases.
During seismic investigations and exploration drilling of the natural gas fields as well as during the construction of the platform, there are increased **noise emissions**. Impacts of sound on fish are described in detail in Chapter 3.2.3 . As already described for sand and gravel extraction, construction-related sediment turbulence, turbidity plumes, and resuspension of sediment particles can affect fish in the short term and locally. Because of the construction-related adverse effects, short-term and small-scale deterrent 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 **habitat loss** 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 (e.g. cod or pout) aggregate on artificial structures (e.g. GLAROU et al. 2020). Detailed information on the impacts of newly introduced structures is described in Chapter 3.2.3 .

Impacts resulting from the escape of pollutants in the event of an accident cannot be ruled out and can be considerable.

The aforementioned impacts of natural gas extraction on fish fauna occur regardless of whether the plan is implemented.

3.4.4 Marine mammals

Sand and gravel mining

Sand and gravel extraction can cause sediment plumes as well as sedimentary changes and the associated damage to or alteration of benthic communities. Temporary effects on marine mammals due to noise emissions from vehicles involved in extraction would also be expected. In particular, turbidity plumes and changes in sediment structure and benthos can affect the quality of habitat for marine mammals. However, these are local and temporary and any disturbance would therefore be negligible.

The non-implementation of the plan would not affect the existing or described effects of sand and gravel extraction on harbour porpoises, harbour seals and grey seals.

Extraction of hydrocarbons

Possible impacts on marine mammals from the construction and operation of offshore platforms for the production of natural gas can be caused by shipping traffic, noise emissions, pollution through leakage and sediment plumes. During normal operation, sediment and benthic changes from platforms are to be expected. 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 can enter the marine environment, which can lead to contamination of marine mammals.

Direct disturbance of marine mammals at the individual level can occur only during the construction phase of gas production platforms. However, effects from shipping traffic and, above all, noise emissions during the construction phase are only expected to be regional and temporary. The formation of sediment plumes is largely to be expected only locally and also for a limited period of time. A habitat loss for marine mammals could thus occur overall locally and for a limited period of time.

Indirect impacts resulting from pollutant discharges during normal operation and accumulation in food chains should be prevented by appropriate state of the art measures. Effects due to the release of pollutants in the event of an incident or accident cannot be excluded. These would mainly occur selectively.

The non-implementation of the plan would not affect the existing or described effects of carbon capture on harbour porpoises, harbour seals and grey seals.

3.4.5 Seabirds and resting birds

Sand and gravel mining

For seabirds, the extraction of sand and gravel may be affected mainly by turbidity plumes and visual disturbance caused by shipping traffic. Indirectly, sedimentary changes and associated changes in benthic communities may affect seabirds and resting birds via the food chain. These impacts are usually weak for seabirds and resting birds because the birds search for their prey organisms mainly in the water column in widely extended areas.

Direct impacts of turbidity plumes on seabirds varies according to species and feeding strategy. Moreover, the turbidity plumes lead to water turbidity only locally.

Shipping traffic during mining operations can lead to avoidance behaviour and thus a temporary habitat loss for species sensitive to disturbance.

Overall, impacts on seabirds and resting birds as a result of 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 effects on seabirds and resting birds are independent of the non-implementation or implementation of the plan.

Extraction of hydrocarbons

For seabirds and resting birds, the construction and operation of hydrocarbon extraction installations may 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 through 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). Accidents can release pollutants and oil 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 from sediment and benthic changes are generally weak for seabirds because they forage for their prey organisms predominantly in the water column in widespread areas.

According to the current state of 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 effects on seabirds and resting birds are independent of the non-implementation or implementation of the plan.

3.4.6 Migratory birds

Sand and gravel mining

Impacts of sand and gravel extraction on migratory birds may exist mainly through attraction effects of the illuminated extraction vehicles. These can be particularly effective at night in poor visibility and weather conditions and can thus lead to collisions.

The above effects on migratory birds are independent of the non-implementation or implementation of the plan.

Extraction of hydrocarbons

During the extraction of hydrocarbons, luring effects can occur because of illuminated structures. Depending on the technical implementation of hydrocarbon extraction, the effects may be comparable to those of offshore wind energy (see Chapter 3.2.6).

The above effects on migratory birds are independent of the non-implementation or implementation of the plan.

3.4.7 Bats

Sand and gravel extraction

Impacts of sand and gravel extraction on bats may exist to a minor extent because of attraction effects of the illuminated extraction vehicles.

The above-mentioned effects on bats are independent of the non-implementation or implementation of the plan.

Extraction of hydrocarbons

During the extraction of hydrocarbons, luring effects can occur because of illuminated structures. Depending on the technical implementation of hydrocarbon extraction, system-related effects comparable to those of offshore wind energy may occur (see section 3.2.7).

The above-mentioned effects on bats are independent of the non-implementation or implementation of the plan.

3.4.8 Air

Sand and gravel extraction

The shipping traffic associated with sand and gravel extraction will cause emissions of pollutants that may affect air quality. Significant adverse impacts on air quality are not expected.

Extraction of hydrocarbons

The extraction of hydrocarbons is associated with emissions that can affect air quality. The emissions come in particular from shipping traffic (e.g. utilities) associated with offshore activities, drilling activities, construction activities (e.g. driving foundation piles) and from the operation of production platforms. During the operation of the platforms, carbon dioxide, nitrogen oxides, and volatile organic compounds (including methane) are emitted. 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. Primarily completely covered, previously unknown wrecks and prehistoric sites are threatened. In addition, dredging can influence flow conditions 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 extraction of stone material, which was performed as a nearshore small-scale stone extraction operation as early as 1840–1930 and to depths of 6–12 m in 1930–1976 (Bock et al. 2003). In addition to altering flow and erosion conditions, wrecks can also be directly affected when the ballast stones over a wreck site are removed.

3.5 Fishing and marine aquaculture

Traditionally, the entire North Sea and Baltic Sea EEZ has been used for fishing. In the North Sea EEZ, a distinction must be made between coastal and cutter fisheries and small-scale deep-sea fisheries. These differ mainly in the size of vessels and motorisation. Large industrial deep-sea fisheries, which land roughly half of the German catch with just a few vessels, do not take place in the German EEZ.

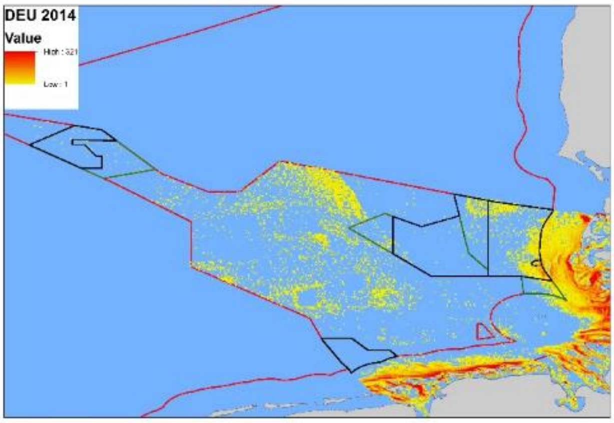
In the North Sea, cutter fishing, mostly with vessels of 18-24 metres in length, accounts for the majority of fishing. Small-scale deep-sea fishing, which only accounts for a small proportion of the German fishing fleet, is carried out deep-sea cutters up to 32 metres in length, which are often more powerful.

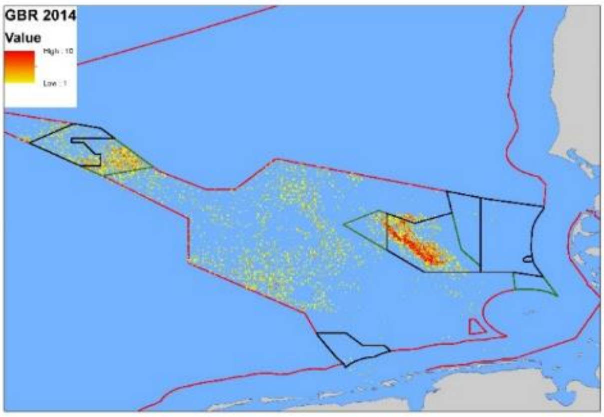
Fishing is mainly demersal (on the seabed) with beam trawls or bottom trawl nets, or pelagic with drag nets.

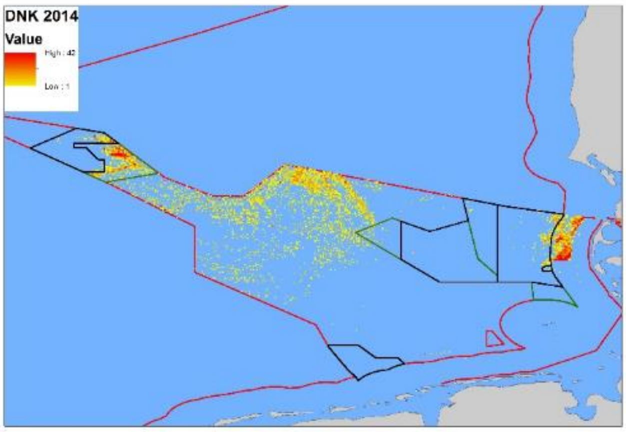
Shrimp fishing (North Sea shrimp, *crangon crangon*) accounts for the biggest proportion of fishing operations and also the biggest catches in the North Sea, as well as flatfish such as plaice or sole. Smaller cutters are allowed to operate in the so-called "plaice box", in the eastern part of the EEZ and the coastal sea, but more powerful motorised vessels may only fish flatfish outside this area. Other target species for pelagic fisheries are herring, mackerel, pollock and cod.

Operations from neighbouring countries, particularly the Netherlands, Denmark and the United Kingdom, account for a large share of the catches, especially of shrimp, but also bigger catches of sprat or sand eel. The latter, on the other hand, are of no significance for German fisheries.

Geographically, several priority areas can be identified on the basis of VMS data, here from 2014 (Thuenen, 2017): the shrimp 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 Silt Bottom, which is a main fishing area for Norway lobster.







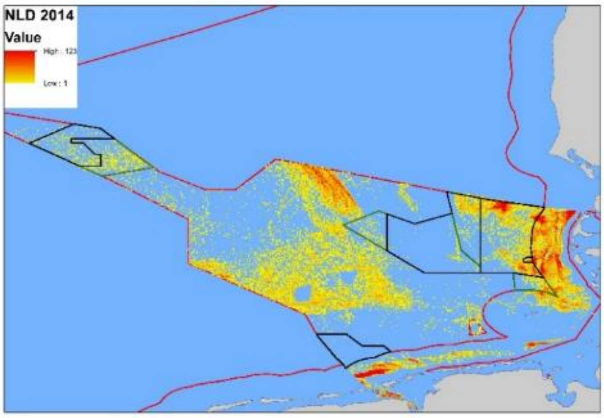


Figure 41: Fishing in the territorial waters and EEZ based on VMS data 2014 for individual national fleets (DEU: Germany; NLD: Netherlands; DNK: Denmark; GBR: Great Britain) (Thünen, 2016)

Development of fishing

On the whole, fishing in the North Sea has been on the decline, with large reductions in yields, particularly with regard to fishing close to the bottom and on the bottom of the seabed. The number of vessels in the German fishing fleet as a whole has fallen from 2315 (2000) to 1329, mainly due to the reduction in the number of vessels in the Baltic Sea.

Just a few (currently 7) globally operating deep-sea trawlers land about half of the German catches. The majority of the remaining vessels, around 1,110, are small gillnet cutters (4 - 10 m long) operating near the coast of the Baltic Sea. These only account for about 4% of the catches. Around 200 shrimp cutters (9 - 27 m long) operate in the North Sea. Bottom trawling, especially for cod and pollock, is carried out by around 70 cutters in the North Sea and the Baltic (Thünen Institute for 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. Particularly the annual fixing of quotas has a major impact on the economic framework conditions of fishing enterprises. For example, the major reductions in the herring and cod quotas in the Baltic Sea for 2020, currently set on the basis of scientific advice, are considered by many businesses to threaten their survival. The economic situation of fishing enterprises is expected to become worse in the coming years.

Spatial restrictions with regard to target species, use of fishing gear or time limits, with proportions in the German EEZ in each case, have been adopted under EU law in the North Sea ("Schollenbox") and the Baltic Sea ("Oderbank"). Fisheries management measures in the nature reserves based on joint recommendations by the states of the Scheveningen Group (North Sea) and the BaltFish Group (Baltic Sea) will be introduced as part of the respective management plans for the NSG. For the North Sea, the draft Joint Recommendation for decision lies with the EU, and only a few proposals have been prepared for the Baltic Sea.

As well as the impact of the EU's Common Fisheries Policy on the fishing sector in the EEZ, the construction of offshore wind farms particularly has geographical implications for fishing. The establishment of safety zones for fixed infrastructures (wind turbines, transformers and converter platforms) has led to a widespread ban on traffic in and around the wind farms. The use of fishing gear such as bottom gears, trawls and driftnets is also generally prohibited in the safety zones. By 2019, large areas in the North Sea and Baltic Sea EEZs will already be closed to fishing. From a fishing point of view there will also be further restrictions on cable connections outside wind farms, which must not be fished over in certain areas 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 be able to keep options open for such marine use in the future, the spatial plan contains a general designation of possible installations in spatial proximity to offshore wind energy plants but without a specific spatial designation.

From various research projects, among others involving the AWI and the TI for Sea Fishing, the following areas in the EEZ of the North Sea 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 deep water anchorage to the Jade, Weser, or Elbe), b) in the Helgoland cluster (Reservation area Offshore Wind Energy EN4), and c) around the current research platform FINO 3 (in the area of the OWF 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 (e.g. ships, transfer of people).

The following potential impacts may occur from fishing exploitation of the EEZ, as well as from aquaculture of extractive species:

Table 19: Effects and potential impacts of fishing and aquaculture (t = temporary).

Use	Effect	Potential impact	Protected assets																
			Benthos	Fish	Seabirds and rest-	Migratory birds	Marine Mammals	Bats	Plankton	Biotopes	Biological diversity	Seabed	Site	Water	Air	Climate	Human/ Health	Cultural and mate-	Landscape
Fisheries	Removal of selected species	Reduction of stocks	x	x							x								
		Deterioration 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					
	Introduction of fixed installations	Modification of habitats	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								
	Introduction of medications	Impairment	x	x										x			x		
	Removal from wild stocks	Impairment	x	x															
	Attraction/scaring effects	Attraction/deterrent effect		x	x		x												

3.5.1 Seabed

Fisheries

The fishing gear used in *bottom-contacting fishing* (e.g. otter trawls, dredges and beam trawls) have an impact on the seabed as a protected resource. Beam trawl fishing is predominant in the German North Sea EEZ, with the greatest intensity being 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 seabed conditions (ICES, 2000). This intervention, which varies in terms of time and location, is subject to relatively rapid regeneration during the course of natural sediment dynamics, meaning that the drag marks usually disappear within a few days or weeks. Nevertheless, the use of bottom trawls does result in some smoothing of the seabed by levelling ripple structures or small elevations. The fishing away of stones can lead to a change in the sediment structure and habitat levelling.

The formation of turbidity plumes near the seabed and possible release of pollutants from the sediment is generally negligible because of the generally low proportion of silt and clay, the low concentrations of heavy metals, and the prevailing flow conditions. In intensively fished areas such as the "Outer Silver Pit" (Äußere Silbergrube), grain refinement on the seabed surface has been observed. In addition to natural causes, this can also be attributed to sediment resuspension by bottom trawls and subsequent resedimentation (TRIMMER et al., 2005).

The impacts on seabed as a protected asset 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 excretions of the crops used. Further adverse effects are to be expected from the preventive or treatment use of medicines and other chemical substances for various purposes. All input substances 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 impacts on the seabed will depend on the type and intensity of the aquaculture.

The prerequisites for marine aquaculture are to be examined at downstream planning levels. The impacts of aquaculture on seabed as a protected asset therfore occur regardless of whether the plan is implemented.

3.5.2 Benthos and biotopes

Fisheries

Fishing for demersal fish species is important for benthos and biotopes. In order to catch fish living on the seabed, equipment is used which penetrates the seabed in some cases, and changes the animal community living there. The fishing gear includes 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). Beam trawl fishing for catching flatfish and prawns is the main activity in the German North Sea EEZ. In the process, the seabed is churned up to a depth of 10 cm by the skids of the beam trawls as well as by the harness (chafing chains or chain mats) (LINDEBOOM et al., 1998). The otter boards of the otter trawl net have the same effect. They usually slide across the ground at an angle and leave furrows which can be up to 10 cm deep (ICES, 2000) depending on the soil conditions. The intensity of bottom fishing varies considerably, with the southern North Sea being the most intensively targeted within the German EEZ. Depending on the behaviour of the fishers, it is not uncommon in this area for the seabed to be fished up to 10 times or more a year with beam trawls or similar fishing gear (EHRICH, 1998).

Fishing activities may kill epibenthos and endobenthos organisms because of the mechanical stress, or they may be removed from the system and returned overboard, usually damaged. The severity of the damage depends not only on the sediment type 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 epibenthos and endobenthos organisms (about 90 per cent) pass through the mesh of the net and are therefore not landed on the deck of the vessels. An unknown proportion of the organisms are 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 cyprina). In general, animals living burrowed in mud-rich seabeds are more sensitive to the scouring chains of beam trawls than animals living in sand (SCHOMERUS et al., 2006). Otter trawls generally have less impact on creatures buried in the seabed, since the otter trawls affect a smaller area than beam trawls. The sedentary epibenthos is affected by otter board fishing to a similar extent to which they are by beam trawls if the otter trawls are equipped with chains instead of a lightweight roller harness as the basic harness.

The effects of fishing gear on benthic communities can be divided into short-term and long-term effects (Weber et al., 1990):

- Short-term consequences. Some of the animals uncovered by the fishing gear are injured or killed. The bigger and hard-shelled representatives, such as sea urchins and swimming crabs, are particularly susceptible to this. Smaller benthic creatures such as brittle stars and thin-shelled small mussels are hardly damaged at all (Graham, 1955). The exposed and damaged creatures are a welcome food for fish from the surrounding area. Margetts and Bridger (1971) made the observation that dabs seemed to be more numerous and feeding more actively in the dragline than in the surrounding area.
- Long-term consequences. Fishing activities increase the mortality of sensitive species until only the opportunists can survive. Species diversity is decreasing at the same time. Abundance increases for species that are not harmed by fishing gear to the extent that the sensitive species disappear from the biotope. Organic matter production could increase first as the older, slow-growing specimens are replaced by fast-growing, young ones. As trawling activity increases, the younger animals will then also die so that production decreases.

In summary, the main impacts of fishing on the marine macrobenthos are as follows:

- Loss of individuals, especially of long-lived and sensitive species, as a result of fishing gear
- Reduction of sessile epifauna
- Decrease in biodiversity
- Shift in the size spectrum of the seabed fauna
- Habitat levelling by the fishing away of stones.

The aforementioned impacts on benthic communities and biotopes occur regardless of whether the plan is implemented.

Aquaculture

Aquaculture involves the production of fish, crustaceans (shrimps), molluscs (mussels), and algae under controlled conditions in special installations in salt 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 pens for rearing fish) depending on the species reared because not all nutrients used in fish cultures are converted into biomass. In addition to the soluble excretory products of breeding, solids can be distributed in the water column and lead to a constant increase in nutrient concentrations in the vicinity of the cage facilities and benthic habitats. Because microalgae cannot convert the nutrient supply in time, excreted solids and uneaten food pellets could therefore accumulate under the cages (depending on the flow), thereby enabling local eutrophication effects (WALTER et al., 2003). Because of the microbial degradation of the substances, there is a risk of oxygen deficiency situations and thus an adverse effect on 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 the biodeposition of faeces or pseudofaeces (LACOSTE et al. 2020). These impacts can vary depending on the species being farmed and are also variable over time. Possible ecosystem impacts (e.g. through attraction, avoidance effects, and food web interactions) cannot be ruled out but have so far been insufficiently investigated (LACOSTE et al. 2020).

The species farmed in aquaculture are often not native species. If such cultivated organisms escape, there is a risk that they will spread. One example of this is the Pacific oyster, which was introduced into German waters through aquaculture.

However, the escape of native species from breeding facilities also threatens the environment under certain circumstances. In addition, parasites from aquaculture facilities can also enter the marine environment (WALTER et al., 2003).

The aforementioned impacts of aquaculture on benthos and biotopes occur regardless of whether the plan is implemented

3.5.3 Fish

Fisheries

Fishing throughout the North Sea involves some 6600 vessels and is concentrated on more than 100 fish populations (ICES 2018a). Some areas of the southern North Sea are fished up to ten times a year with bottom-towed gear (ZIDOWITZ et al. 2017). In the southern North Sea, the main traditional fishing is for North Sea prawns in territorial waters. Flatfish fishing in the German EEZ targets pollock, cod, plaice and sole (ICES 2018a). Fishing often involves not only hauling heavy bottom gear but also using relatively small meshes; as a result of this, the by-catch 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 2.7.3 Legacy impact). Population developments which are negative to critical are a major problem in the North Sea, as is the by-catch of young stocks, since this deprives the stocks of their future reproductive potential. As a result, the full reproductive potential of North Sea commercial fish populations is often not available. In addition to direct mortality of target species, non-targeted by-catch species are potentially threatened as a result of fishing. In particular, sharks and rays are very sensitive to fishing pressure because of very slow growth, late sexual maturity, and low fecundity with the possible consequence of stock declines in the North Sea (ZIDOWITZ et al. 2017). In addition, demersal fishing has a negative impact on invertebrates, which are 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 the fish as a result of size-selective fishing methods. Primarily larger older individuals are taken; the proportion of smaller younger individuals in the fish community thus 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 thus possibly 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).

As well as the direct effects of fishing, the discharge of marine waste, particularly plastic waste, can have indirect negative effects on fish populations. Particularly abandoned fishing nets, which drift around for decades and continue to catch fish, represent a problem for fish populations. Mortality from fishing ghost nets could contribute to stock decline and be a problem especially for threatened fish species.

The aforementioned impacts of fishing on fish fauna occur regardless of whether the plan 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 is to be regulated at subsequent planning levels, taking into consideration the special features of the project area. Suitable aquaculture sites could mainly be the OWF closer to the coast because costs and effort increase with increasing distance from the coast.

In general, aquaculture can reduce fishing pressure on some wild fish stocks. In this context, abstaining from the use of juvenile fish from wild stocks is crucial. Marine aquaculture can have an adverse effect on fish fauna, particularly through the introduction of diseases and invasive species as well as an increase in nutrients and pollutants.

During disease outbreaks, parasites and pathogens can lead to an increased risk of transmission to natural stocks in the surrounding water close to the installation. The escape of cultivated organisms is also problematic; if they mingle with natural conspecifics and engage in reproduction, genetic diversity can be threatened as a result (WALTER ET AL. 2003). If alien fish species escape and are able to establish themselves, native fish species may be displaced. Stocking of net cages for fish rearing should therefore only be done with native species.

A further adverse effect can come from the input of nutrients and pollutants. Intensive feeding, especially when fish are reared in net cages, increases nutrient concentrations and can load the seabed with organic cargo. These environmental impacts could be mitigated with an adapted stocking density and a more spacious 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 aforementioned prerequisites for marine aquaculture are to be examined at downstream planning levels. The aforementioned impacts of aquaculture on fish fauna therefore occur regardless of whether the plan is implemented.

3.5.4 Marine mammals

Fisheries

The majority of fishing in the North Sea is carried out using beam trawls and towed nets. The main threat to harbour porpoises in the North Sea is unwanted by-catch in nets (ASCOBANS, 2003, Evans 2020).

The non-implementation of the plan would not affect the existing or described impacts of fishing on harbour porpoises, seals and grey seals.

Aquaculture

If mariculture were established, marine mammals would be affected indirectly through water quality degradation and food chains: pollutants, especially growth hormone preparations and antibiotics, could impair the immune system of marine mammals. Changes at the bottom of the food chains could affect the entire food chain and therefore the predators at the top of the food chain, such as marine mammals.

It cannot be ruled out that seal deterrence measures, which are often used in fish aquaculture operations, would also produce the effect of disturbing the stock of harbour porpoise.

According to the current state of knowledge and because of a lack of concrete planning, it is not possible to assess impacts from aquaculture in the EEZ.

The non-implementation of the plan would not affect the existing or described effects of mariculture on harbour porpoises, seals and grey seals.

3.5.5 Seabirds and resting birds

Fisheries

Fishing influences the occurrence of seabirds. Discards of by-catch from fishing activities provide additional food sources for some seabird species. This creates concentrations around fishing vessels. In particular, Northern fulmar, skua, the lesser black-backed gull, herring gull, and the greater black-backed gull benefit from discards. In one study, a trend towards increased numbers of birds (lesser black-backed gull, herring gull, common gull and black-headed gull) with a corresponding increase in the number of fishing boats was 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. There is also the risk of dying as by-catch in fishing nets.

The overfishing of important stocks, which are the food basis 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 include the reduction in reproductive success and the adversely affected survival of many bird species. In particular, impacts of overfishing and declines in 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 related to the decline of sand eel as the main food for chicks. The spread of the sand eel-like pipefish in the North Sea, which is often used by parent birds to feed their chicks instead of sand eel, does not constitute an equivalent food according to scientific findings. Because of the hard consistency of the pipefish, the young birds are unable to use them as food. This leaves them malnourished or starving (WANLESS et al. 2006).

Impacts 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 installations. These cause small-scale visual and acoustic disturbance and scaring*.

The above-mentioned effects of fisheries and aquaculture on sea birds and resting birds are independent of the non-implementation or implementation of the plan.

3.5.6 Migratory birds

Fisheries

Migratory birds may be disturbed and frightened by fishing depending on the frequency of use of the marine areas. Migratory waterfowl that interrupt their migration to feed also run 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 installations. These cause small-scale visual and acoustic disturbance and scaring*.

The aforementioned impacts of fishing and aquaculture on migratory birds occur regardless of whether the plan is implemented.

3.5.7 Cultural assets and other material assets

Fishing with trawls can contribute to the destruction of archaeological layers and wreck finds. The trawls and their trawl boards penetrate the sediment of the seabed and can leave furrows up to 50 cm deep and 100 cm wide on a fine sandy bottom, which can even be seen in the side scan sonar image (Firth et al. 2013, 17). In some cases, the proximity to wrecks, which form natural habitats as hard substrate and in the vicinity of which larger fish populations can be expected is deliberately sought. There are already many documented examples worldwide of the 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. In accordance with Section 56, Paragraph 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 measuring stations in the German EEZ and a few more in the territorial waters in the North Sea and Baltic Sea. The systematic 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.

In the North Sea, this also includes the first FINO measurement mast (Research Platform in the North Sea and Baltic Sea – 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 constructed - as well as for monitoring changes, disturbances, effects and interactions after the offshore wind farms are constructed. All measuring masts are now located in or near the wind farms mentioned above.

The Alfred Wegener Institute for Polar and Marine Research (AWI), the Thuenen Institutes, the Institute for Baltic Sea Research (IOW) and other research institutions operate measuring stations in the North Sea and the Baltic, conduct surveys on various research and monitoring issues and tasks. This is associated with different requirements regarding 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 and Walter Herwig III) since 1987.

The TI is investigating abundances and distribution patterns of bottom-dwelling fish in the North Sea on a small scale. For this purpose, 12 standard survey areas (“boxes”), each 10 × 10 nautical miles in size, are surveyed annually with a standardised bottom trawl. This dataset provides 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 GOV-type high stowage otter trawl. In parallel, epibenthos (by means of a 2 m beam trawl), infauna (by van Veen grab) and sediments will be studied, and hydrographic and marine chemical parameters of habitats typical for the region will be recorded.

The following impacts on the marine environment are possible through the use of marine scientific research.

Table 20: Effects and potential impacts of marine research (t= temporary).

Use	Effect	Potential impact	Protected assets																
			Benthos	Fish	Seabirds and resting birds	Migratory birds	Marine Mammals	Bats	Plankton	Biotopes	Biological diversity	Seabed	Site	Water	Air	Climate	Human/ Health	Cultural and material assets	Landscape
Marine research	Removal of selected species	Reduction of stocks		x															
	Physical disturbance by trawls	Impairment/ damage to by-catch	x	x						x		x						x	

3.6.1 Seabed

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 protected asset seabed are fishery research activities, which can lead to physical disturbance of the seabed surface by trawl nets (see Fishing Chapter 3.5.1). Bottom trawls on sandy soils generally penetrate the seabed to a depth of several millimetres to centimetres.

It cannot be ruled out that grain sorting may occur on the seabed as a result of the accumulation of previously churned up fine sandy sediment on the seabed surface due to regular fishing. The argument against this is that because of the natural sediment dynamics, especially during intensive sand relocations during storms, the upper decimetres are completely mixed. A largely natural sediment composition is thus restored. One of the consequences of this is that drag lines are not usually permanently seen on the predominantly sandy seabeds of the EEZ.

The formation of turbidity plumes near the seabed and the 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 seabed as a protected asset are independent of the non-implementation or implementation of the plan.

3.6.2 Benthos and biotopes

The various marine research activities 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 the death of individual benthic organisms. Similarly, a small amount of material emissions of various kinds are recorded when specific processes and equipment are used. In principle, it can be assumed that intensive research activities, especially on sensitive species or in sensitive habitats, can lead to considerable environmental impacts. Overall, however, it can be assumed that marine research is aimed at minimising environmental impacts and is adapted to the requirements for the protection of endangered species.

In summary, the main impacts of research activities on the marine macrobenthos are as follows:

- local, temporary damage or loss of individuals because of sampling
- local, temporary impact because of the increase in pollutant inputs.

The aforementioned impacts on benthic communities and biotopes occur regardless of whether the plan is implemented.

3.6.3 Fish

The various marine research activities are associated with different impacts for the fish fauna depending on the type of methods and equipment used. Sampling can lead to varying degrees of damage and even the death of 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. However, marine research in the North Sea generally serves to identify negative developments in the ecosystem at an early stage and make targeted recommendations. In the long term, diverse marine research can thus make an important contribution to the conservation of the marine environment.

The aforementioned impacts of marine research on fish fauna occur regardless of whether the plan is implemented.

3.6.4 Marine mammals

The potential impacts of research on marine mammals are: small-scale and temporal impacts from by-catch in fishery research, local temporal impacts from fishing vessels, and sub-regional temporal impacts from seismic and other sound-intensive research activities.

The non-implementation of the plan would not affect the existing or described impacts of marine research on harbour porpoises and on harbour seals and grey seals.

3.6.5 Seabirds and resting birds

Depending on its objectives and design, marine research can have different impacts on seabirds and resting birds. Fishery research focuses on by-catch and discard impacts. The use of ships may cause visual disturbance effects on disturbance-sensitive species, thereby triggering avoidance behaviour. Indirectly, fishery 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.

Because of the small-scale, time-limited activities of scientific research, significant impacts on seabirds can be ruled out with certainty.

The above-mentioned effects on seabirds and resting birds are independent 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 may be relevant. However, these have a small-scale and temporary effect.

In addition, research activities may be associated with the installation of building structures. These could conceivably have impacts at night in poor weather conditions when migratory birds are attracted by illuminated structures and could collide.

The above-mentioned effects on seabirds and resting birds are independent 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 were not implemented, the same impacts on bats may occur as if the plan is implemented.

3.6.8 Cultural assets and other material assets

When assessing the impacts of marine research or even archaeological research, it is important to distinguish 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 effects. On the contrary, the results could also be used for research into the underwater cultural heritage.

When taking seabed samples through cores, archaeologically relevant layers could be pierced; however, their disturbance is insignificant because of the small scale. Sampling by excavator grippers may interfere more with the potential cultural assets. However, information acquired in the survey and reporting of archaeological finds is usually of higher value than the problems caused by destruction.

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 consideration when other uses claim it. 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.

In accordance with Article 57 of the Federal Nature Conservation Act (BNatSchG), the ordinances of 22 September 2017 included the existing bird protection areas and FFH areas in the German EEZ in the national area categories and declared them nature conservation areas. Within this framework, they were partially regrouped. For example, the Regulation on the designation of the nature conservation area "Sylt Outer Reef - Eastern German Bight" (NSGSylV), the Regulation on the designation of the nature conservation area "Borkum Reef Ground" (NSGBRgV) and the Regulation on the designation of the nature conservation area "Dogger Bank" (NSGDgbV) now establish the nature conservation areas "Sylt Outer Reef - Eastern German Bight", "Borkum Reef Ground" and "Dogger Bank".

Article I, 6 paragraph 1 of the Habitats Directive provides that Member States shall establish the necessary conservation measures and, where appropriate, prepare management plans. On 17 November 2017, BfN initiated the participation procedure for the management plans for the nature conservation areas in the German North Sea EEZ. All three management plans came into force on 13.05.2020.

As well as the conservation areas that were defined by law on 22.09.2017, the planning also includes the nature conservation guidelines of the BMU, which is based on the position paper of the business unit of the Federal Environment Ministry on the cumulative assessment of the loss of diver habitat due to offshore wind farms in the German EEZ of the North and Baltic Seas in 2009 (main distribution area of 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 Abatement Concept of 1 January 2009 December 2013 (main concentration area of harbour porpoises in the German EEZ from May to

August). This is the basis upon which the assessment criteria under species protection law were adjusted.

3.7.1 Seabed

National marine conservation areas and the associated management plans are intended to achieve or maintain the favourable conservation status of habitat types such as "reefs" and "sandbanks" and biotopes such as the "KGS beds", among other things. This can also reinforce the protection of the low occurrence of coarse sediments (gravel, coarse sand), residual sediments and boulders in the German EEZ. In addition to measures for reducing the negative impacts of trawling and the extraction of sand and gravel, other planned measures in the management plans are also associated with positive effects for the seabed as a protected resource, such as the reduction of adverse impacts from pollutant inputs.

Because the spatial plan supports nature conservation through the designation of priority areas, the protection of the seabed in national marine protected areas would probably be less well ensured if the plan were not implemented.

3.7.2 Benthos and biotopes

The objective 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 conditions 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 on benthic habitats of designating nature conservation areas as priority areas would probably be less likely to be achieved.

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 "Borkum Reef Ground" and "Sylt Outer Reef - Eastern German Bight" nature reserves are of particular importance for fish as a protected species. The FFH twaite shad species uses both marine conservation areas as a feeding habitat. The "Sylt Outer Reef - Eastern German Bight nature reserve is a feeding and migration area for the FFH river lamprey species. The availability of food in the "Sylt Outer Reef - Eastern German Bight" nature reserve is occasionally very good because of 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 have shown 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 with 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 impact of nature conservation areas on the fish community in the North Sea. A direct transfer of the available international findings is only possible to a limited extent because important influencing variables (e.g. other uses in the protected area or climatic changes) are largely not taken into consideration. In general, scientific findings suggest that benefits to fish fauna are higher in nature conservation areas without any uses compared to partially protected areas (LESTER & HALPERN 2008, SCIBERAS et al. 2013). In German marine conservation areas, other uses such as fishing or raw material extraction are permitted in some cases. However, the impacts of these uses on the species protected under the Protected Area Ordinance, namely the fin and river lamprey, were assessed as low to negligible

(BFN 2017). Overall, according to current knowledge, the marine conservation areas in the North Sea can have a significant positive impact on the fish community.

3.7.4 Marine mammals

The protection of threatened and characteristic species and habitats is of great importance for the maintenance of healthy marine ecosystems and marine biodiversity. The extension of the Natura 2000 network and the designation of the "Borkum Reef Ground", "Sylt Outer Reef - Eastern German Bight" and "Dogger Bank" nature reserves contributes 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 stocks and habitats. In this context, nature reserves and other areas of particular importance have an important function in maintaining ecological links between the different levels of the food web. Adequate protection of habitats also serves the protection of threatened 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 for seabirds and resting birds described in Chapter 3.7.5 therefore 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 territorial waters 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.
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 exercise 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.

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, shooting and blasting can be done anywhere at sea if the necessary conditions (water depths, weather conditions, sea area checked and free of vehicles) are available. Shooting 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 carry out regionally based evaluations for consumption of different ammunition types and calibres. In general, artillery ranges are fired with practice ammunition consisting of metal and concrete as well as ammunition that self-destructs in the air. Apart from a few exceptions, the flying combat units of the air force use only training ammunition in the training areas*.

Only small residues are produced during firing exercises with barrel weapons, missiles, and torpedoes in “live” fire. If missiles are used, they or their seekers are recovered immediately after the end of the exercise provided they are not detonated. When firing practice ammunition with barrelled weapons, the metal bullets filled with a gypsum-concrete mixture remain in the practice area. After firing practice torpedoes, they are retrieved and returned to the depot.

Some areas are subject to voluntary usage restrictions; for example, underwater blasting is not carried out in the exercise areas during certain periods in order to minimise negative impacts on fishing and marine mammals.

For military training operations, regulations are in place to protect marine mammals during the use/generation of underwater noise during the use of both sonar and underwater blasting. The following measures are planned:

- Obtain information on the possible presence of marine mammals.
- Visual and acoustic monitoring of hazard areas prior to blasting.
- Implementation of deterrence measures before blasting.
- If marine mammals are spotted 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 assets.

Table 21: Effects and potential impacts of national and allied defence (t = temporary).

Use	Effect	Potential impact	Protected assets																
			Benthos	Fish	Seabirds and rest-	Migratory birds	Marine Mammals	Bats	Plankton	Biotopes	Biological diversity	Seabed	Site	Water	Air	Climate	Human/ Health	Cultural and mate-	Landscape
National defence	Underwater Sound	Impairment/ chickening out effect		x t			x												
	Introduction of dangerous* substances	Impairment	x	x	x		x		x	x	x	x		x			x		
	Risk of collision	Collision					x												
	Surge noise*	Impairment/ scaring effect			x	x		x									x		
	Introduction of waste	Impairment	x	x					x					x			x		

3.8.1 Seabed

Military activities in connection with national and allied 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 seabed and water contamination is the ammunition residues left in the shooting areas or the remains of blasting operations.

The general impacts of national and allied defence on the protected asset seabed arise independently of the implementation or non-implementation of the plan.

3.8.2 Benthos and biotopes

Because of the ammunition residues remaining in shooting areas*, there may be a release of pollutants, which can adversely affect benthic communities in their biotopes.

The impacts of national and allied defence occur regardless of whether the plan is implemented.

3.8.3 Fish

Particularly the fish population could be affected by underwater noise and the introduction of dangerous substances by military uses. Depending on the level, underwater noise can lead to deterrent effects (shipping traffic) and even the death of individual fish (e.g. detonation). For detailed impacts of underwater noise on fish fauna, see Chapters 3.2.3 and 3.1.3 . In general, military activities such as shooting exercises or submarine manoeuvres are limited in space and time.

Other adverse effects of military events could result from the release of toxins from the estimated 1.3 million tonnes of munitions and wrecks on the seabed of the North Sea. There is little knowledge about the extent to which progressive corrosion promotes the release of toxic substances and how these affect the health of fish. 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 with an uncontaminated reference area (Lang et al. 2017). Nevertheless, an increased accumulation of pollutants in fish cannot be ruled out. There is a need for research on impacts on different species and life stages, reproductive capacity, and the spread of toxic substances through the food web.

The aforementioned impacts of national and allied defence on the fish fauna occur regardless of whether the plan is implemented.

3.8.4 Marine mammals

For marine mammals, possible impacts are due to military exercises associated with the input of underwater noise. In particular, sonars and blasting are relevant. Studies in deep water areas (> 1000 m) have shown that the use of military sonar has caused disturbance, injury, and even stranding of cetaceans (Azzellino et al., 2011, Zirbel et al., 2011). Blasting of old ammunition also has the potential to injure and kill animals if no protective measures are taken. For this reason, protective measures, including observation of the immediate vicinity and scaring away* the animals, are regularly taken during blasting operations,.

The overall impacts of land defence on marine mammals does not differ between non-implementation or implementation of the plan.

3.8.5 Avifauna

General impacts of land defences 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 (e.g. the release of toxic substances).

The general impact of national defence on birds does not distinguish between non-implementation or implementation of the plan.

3.9 Other uses without spatial specifications

No spatial specifications are made for other uses.

3.9.1 Leisure activities

3.9.1.1 Fish

Impacts of recreational activities on fish fauna are to be expected – in particular from fishing and recreational traffic. Recreational fishing accounted for about 1.4 million days of active fishing in the German Bight in 2013/2014; 10% of this was in the North Sea (HYDER et al. 2018). Catches from recreational fishing usually do not have to be reported to government institutions. There are therefore no scientifically usable catch statistics for the North Sea (BFAFi 2007).

For individual species, the European Fisheries Policy regulates the removal for recreational fishing (EU, 2020). Catches of sea bass and salmon from recreational fishing are significant throughout the North Sea. The ICES thus takes these catches into consideration for stock assessments (ICES 2018a). The removal of individual fish by anglers and hobby fishermen could contribute to the decline in the stocks of the species caught, whereby negative effects on the population situation of endangered species would be expected to a particular extent. These impacts are partially mitigated by EU regulations. The extent to which the fish community in the North Sea is adversely affected and the impacts of fishing mortality on individual stocks cannot be estimated at present. Further adverse effects from recreational traffic are caused by underwater noise (for details, see Chapter 3.1.3) and by sludge inputs* (see Chapter 3.5.3).

The aforementioned impacts of recreational activities on fish fauna occur regardless of whether the plan is implemented.

3.9.1.2 Marine mammals

Impacts may occur to marine mammals, particularly from recreational activities that involve input of underwater noise or disturbance of seal resting sites (HERMANNSEN et al., 2019.

The aforementioned impacts of recreational activities on marine mammals occur regardless of the non-implementation or implementation of the plan.

3.9.1.3 Avifauna

The general effects of recreation on birds can particularly be caused by visual disturbance from recreational traffic. In addition, there may be direct and indirect effects via the food chain through the disposal and introduction of litter into the marine environment.

The general impact of recreation on birds does not distinguish between not implementing or implementing the plan.

3.10 Interrelationships

It is assumed that the interrelationships between the protected goods will develop in the same way regardless of whether the plan is implemented. At this point, please refer to Chapter 2.18 .

4 Description and assessment of the likely significant impacts of the implementation of the 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 spatial plan.

According to Section 8 of Germany's Federal Regional Planning Act (ROG), the probable significant impacts of the Spatial Plan on the protected assets must be described and evaluated. The spatial plan sets a framework for downstream planning levels.

The protected assets for which a significant adverse effect were already ruled out in Chapter 2 are not taken into consideration. This applies to the protected assets plankton, air, cultural heritage, and other material assets as well as to the protected asset human beings, including human health.

Possible impacts on the protected asset biological diversity are dealt with under the individual protected biological resources. All the protected assets listed in Section 8, paragraph 1 ROG are investigated before the species protection and site protection assessments are presented.

The basic impacts of the designations of the ROP on the protected asset land – in particular area use by the uses – are summarised in Chapter 2.1. Because of the following points, an assessment of the extent to which the designations of the ROP have impacts on the protected asset area is possible only in a synopsis of all uses:

- Temporally and spatially overlapping uses possible
- Mostly no 100% permanent land consumption of a use
- Unlike on land, not all uses actually consume land in the sense of seabed.

In the ROP itself, such a summary consideration was carried out in the context of the designations on uses with regard to the protected asset land. For this reason, the protected asset land is not considered further in the following; this avoids repeatedly discussing fundamental impacts and designations of the ROP – in the context of area use.

4.1 Shipping

The spatial development plan defines the priority areas for shipping SN1 to SN18 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 designations in the spatial plan.

The designated priority areas for shipping are to be kept free of building use. This control in the ROP reduces collisions and accidents. Based on the provisions of the ROP, the frequency of traffic in the priority areas is expected to increase due to displacement and bundling effects. Ship movements on shipping routes SN1 to SN18 vary greatly; the busiest route SN1 sometimes carries more than 15 ships per km² per day, while on the other, narrower routes, it is mostly around 1-2 vessels per km² per day (BfN 2017).

The BSH has commissioned an expert report on the traffic analysis of shipping traffic and will use the evaluations for the future assessment of shipping traffic.

The presentation of general impacts from shipping is presented in Chapter 2 as a legacy impact, particularly on birds and marine mammals. The impacts of service transport to the wind farms are discussed in the chapter on wind energy.

As a precautionary measure, the definition of priority areas for shipping serves to minimise risk. In addition, it must be taken into account that the freedom of navigation must be ensured in accordance with United Nations Convention on the Law of the Sea (UNCLOS) and that the possibility of regulation by the International Maritime Organization (IMO) is much stronger in international conventions than in the Spatial Plan.

4.1.1 Seabed

As the impacts of shipping on the seabed occur independently of whether or not the plan is implemented, the Spatial Plan does not have any other impacts than those described in Section 3.1.1. The principle of the ROP to reduce pressures on the marine environment through best environmental practice in accordance with international conventions can contribute to the avoidance of pollutant inputs.

In summary, significant negative impacts on the seabed can be excluded due to the ROP's provisions on shipping.

4.1.2 Water

The impacts of shipping on the protected water resource arise independently of the implementation of the ROP. In this respect, significant impacts on the protected asset can be excluded by the provisions for navigation.

4.1.3 Benthos and biotopes

With regard to the use of shipping, there are no further specific impacts of the designations of the ROP on the benthos or biotopes compared with the general effects of use described in Chapter 3.1.2 . Significant impacts on benthic communities and biotopes because of the designations of the ROP on shipping can therefore be ruled out.

4.1.4 Fish

The impacts of shipping on the protected asset fish are presented in Chapter 3.1.3 .

National spatial planning is subject to the freedoms of the UNCLOS, including freedom of shipping. Furthermore, in international conventions, shipping is regulated by the IMO. The area designations for shipping in the ROP are therefore not expected to have any additional or significant impacts on fish fauna.

4.1.5 Marine mammals

The priority area designations for shipping are based in particular on existing shipping routes identified in the procedure for the update of the ROP. These definitions keep important shipping routes free of incompatible uses – in particular by structural facilities – which contributes to reducing impacts. The definition of priority areas for shipping does not have a direct concentration and steering effect on shipping traffic. Shipping can continue to use the entire maritime space in the future. In this respect, the area designations for shipping have no additional impacts on marine mammals as a whole compared with the current situation and the zero alternative.

The ROP also makes statements regarding the reduction of the burden on the marine environment to be aimed for by observing the regulations of the IMO and taking into consideration the 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 assets.

Based on the above statements and the presentations in Chapter 3, it can be stated for the SEA that the provisions for shipping in the ROP are not expected to have any significant impacts on marine mammals, but rather, compared with not implementing the plan, adverse impacts are avoided, 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 definitions of priority areas for shipping reflect the main traffic flows in the EEZ where shipping is given priority over other uses of spatial importance. This objective of spatial planning, in particular, prevents conflicts (collisions) with offshore wind farms and subsequently prevents potential disasters affecting the marine environment and, thus, also sea birds and resting birds. The provisions for navigation do not automatically lead to an increase in the volume of traffic in the priority areas, since navigation enjoys special freedom under Art. 58 UNCLOS and is, therefore, not bound to specific routes. However, certain displacement and bundling effects can be expected.

Additional or significant impacts of the designations for shipping 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 designations of the ROP compared with the general impacts described in chapter 3.1.6. Significant impacts on migratory birds due to the provisions of the Spatial Plan governing 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 designations of the ROP compared with the general impacts described in chapter 3.1.7. Significant impacts on bats based on the provisions of the ROP governing shipping can be ruled out with the necessary degree of certainty.

4.1.9 Air

Shipping generates 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 designations on shipping.

4.2 Offshore wind energy

The ROP contains designations on priority and reservation areas for wind energy. In particular, the area specifications of the sectoral plan for wind energy – SDP 2019/SDP 2020 – are taken into consideration. With the priority areas EN1 to EN3 and EN6 to EN8, the area definitions N-1 to N-3, N-6 to N-8 in FEP 2019 are adopted as priority areas. The areas of SDP 2019 N-9 to N-13 have been extended in a north-westerly direction and are identified in the ROP as priority areas EN9 to EN13. For areas EN4 and EN5, the areas shown in FEP 2019 under review are defined as priority areas. The areas EN14 to EN19 are defined as reserved areas. In the following, the area designations are examined only insofar as they have additional impacts and have not already been fully addressed in the Strategic Environmental Assessment (North Sea Environmental Report) for SDP 2019/SDP 2020.

The construction and operation of wind turbines and ancillary installations in the areas can have a number of impacts on the marine environment, including local habitat loss due to permanent land sealing, chilling and barrier effects and a consequent loss of habitat for avifauna. Also to be considered are potential impacts of maintenance and service traffic.

4.2.1 Seabed

The construction and operation of offshore wind turbines tends to have local impacts on seabed as a protected asset (see Chapter 3.2.1); these occur independently whether the spatial plan is implemented. However, by defining priority and reserved areas for the use of offshore wind energy, negative impacts on the seabed are reduced by coordinating the areas eligible for the erection of WTGs and thus reducing land use. No wind energy plants and platforms are planned in marine nature reserves, in particular due to the legal requirements of the WindSeeG. In addition, the ROP contains designations for spatially coordinated laying and, if necessary, a smaller number of cable systems, the lowest possible number of cable crossings, and a gentle laying cable laying procedure.

The expansion of wind energy within the priority areas is already regulated in detail in SDP 2019/SDP 2020. This also contains the spatially coordinating provisions that are positive for the marine environment.

The designation of the reservation areas is likely to lead to the installation of WEP 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 should not be feared, as the effects will be temporary and mostly very small-scale. In these areas, the seabed site consists of fine sand with sometimes considerable silt and clay content. In areas with a higher proportion of fine sand, the impact will increase slightly during the construction phase of the facilities due to resuspension of sediment and turbidity plumes. Local sealing of the seabed will be very low, as in the existing wind farm areas.

In conclusion, it should be noted that the stipulations for wind energy in the spatial development plan are associated with an expansion of the usable area for wind energy. However, no significant negative impacts on soil as a protected good are to be expected. On the contrary, compared to the non-implementation of the plan, negative impacts can be avoided by the coordinating spatial provisions.

4.2.2 Benthos

Wind energy use may have impacts on the macrozoobenthos. These impacts apply equally to all designated areas for wind energy use.

The EEZ of the North Sea is not of outstanding importance with regard to the species inventory of benthic organisms.

<u>Construction-related:</u> Deep foundations for wind turbines and platforms cause disturbances to the seabed, sediment turbulence and the formation of turbidity plumes. This can lead to the impairment or damage of benthic organisms or communities in the immediate vicinity of the installations for the duration of construction activities. During the construction of the installations, the resuspension of sediment in particular leads to direct adverse effects on the benthic community. Turbidity plumes are to be expected during the foundation work for the installations. However, the concentration of suspended material usually decreases very quickly with removal. Due to the predominant sedimentary composition, the sediment released will settle quickly.

<u>Depending on the installation,</u> changes in the benthic community may occur due to the sealing of the site, the introduction of hard substrates and changes in the flow conditions around the installations. In the area of the installations and the associated scour protection, there will be land sealing/area use and thus a complete loss of soft bottom macrozoobenthos habitats.

In addition to habitat losses or habitat changes, new off-site hard substrate habitats are created. This can have an impact on the soft seabed fauna in the immediate vicinity. According to KNUST et al. (2003), the introduction of artificial hard substrate into sandy seabeds leads to the settlement of additional species. These species will most likely be recruited from natural hard substrate habitats, such as superficial boulder clay and stones. This means that the risk of negative impacts on the benthic sandy seabed community by non-native species is low.

Based on current knowledge, operational impacts by wind turbines and platforms on macrozoobenthos are not expected.

Based on the above statements and representations, the result of the SEA is that, according to the current state of knowledge, no significant impacts on the protected asset benthos are to be expected from the designation of areas for wind energy in the ROP. Overall, the impacts on the protected asset benthos are assessed as short-term and small-scale. Only small-scale areas outside protected areas are used and, due to the usually rapid regeneration capacity of the existing populations of benthic organisms with short generation cycles and their widespread distribution in the German Bight, rapid recolonisation is very likely.

4.2.3 Biotopes

Possible impacts from wind energy use on biotopes in the protected asset can result from direct use of protected biotopes, possible covering by sedimentation of construction-related material released during construction and potential habitat changes.

Considerable construction-related use of protected biotopes by the installations is not to be expected for areas EN1 to EN18, since protected biotope structures pursuant to Article 30 of the Federal Nature Conservation Act (BNatSchG) are to be avoided as far as possible within the framework of the specific approval procedure. Because of the predominant sediment composition in areas where occurrences of protected biotopes are to be expected, adverse effects as a result of sedimentation are likely to be on a small-scale because the released sediment will settle quickly.

For Area EN19, which is located on an occurrence of the biotope “sublittoral sandbanks” protected according to Section 30, paragraph 2, No. 6 BNatSchG, it must be ensured that the orientation values for relative and absolute area loss in accordance with LAMBRECHT & TRAUTNER (2007) and BERNOTAT (2013) are not exceeded.

Permanent habitat changes occur as a result of the installation; however, 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). Significant impacts on the protected asset biotopes from these small-scale areas are not to be expected. In addition, it is highly probable that species will be recruited from natural hard substrate habitats, such as superficial boulder clay and stones. This means that the risk of negative impacts on the benthic soft soil community by non-native species is low.

According to current knowledge, operational impacts from 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 has been identified unanimously. According to the current state of knowledge, it is equally true for all priority areas that no significant impacts at the population level are to be expected from the construction, foundations, and operation of wind turbines. Detailed information on the impacts of offshore wind energy on fish fauna is described in Chapter 3.2.3.

The designations of priority and reservation areas for offshore wind energy in the ROP offers the possibility of sustainable development with as few conflicts of use as possible . Protection claims of the marine environment are coordinated through the designations, thereby avoiding disturbance of valuable habitats such as nature conservation areas.

Based on the current state of knowledge, it can therefore be stated for the SEA that no additional or significant impacts on the protected asset fish are to be expected as a result of the area designations for wind energy in the ROP compared with the non-implementation of the plan.

4.2.5 Marine mammals

The overall impacts of WT on marine mammals through the designation of the priority areas for wind energy is expected to be insignificant. This is also true when considered cumulatively.

The function and importance of the priority areas in the German EEZ of the North Sea for harbour porpoises were assessed in Chapter 2.8 according to the current state of knowledge.

By establishing priority and reserved areas for offshore wind energy production outside nature reserves, disturbances within valuable habitats of particular importance as feeding and rearing grounds are avoided. The designation of the porpoise reserve also allows for better protection during the sensitive period by strict measures ordered as part of the downstream authorisation procedures.

In addition, designations have been made for the protection of the marine environment with regard to the consideration of best environmental practices in accordance with the OSPAR and Helsinki Conventions as well as the state of the art. In this context, regulations on the avoidance and mitigation of negative impacts on marine mammals caused by the construction and operation of WEP, in particular in the form of noise minimisation requirements, which may also provide for the coordination of construction work on projects erected at the same time, are to be adopted at the approval level. This corresponds to current licensing practice. Based on the function-dependent significance of the priority areas for wind energy and the principles contained in the spatial plan as well as the measures ordered in the downstream approval procedures and taking into consideration the current state of science and technology in the reduction of impulsive noise inputs, significant impacts for harbour porpoise, harbour seal, and grey seal can be ruled out. Direct disturbance of marine mammals at the individual level by sound emissions during the construction phase, in particular during pile driving, is to be expected on a regional and temporal scale. However, because of the high mobility of the animals and the aforementioned measures to be taken to avoid and mitigate intensive noise emissions, significant impacts can almost certainly be ruled out. This is also true from the point of view that shipping could have impacts on marine mammals sensitive to disturbance because these impacts are very short-lived and local. The formation of sediment plumes is largely to be expected on a local and temporal scale. A habitat loss for marine mammals could thus occur locally and for a limited period of time. Impacts from sediment and benthic changes are insignificant for marine mammals because they forage for their prey organisms predominantly in the water column in widespread areas. Impacts at the population level are not known and are rather unlikely because of predominantly short-term and local effects in the construction phase.

Significant impacts from WTGs in the priority areas during the operational phase on marine mammals can also be excluded with certainty on the basis of 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 been observed only during the installation of the foundations; this may be related to the large number and varying operating conditions of vehicles on the site.

In summary, the establishment of priority areas outside the main feeding and rearing areas for harbour porpoises indirectly serves to protect the species. The priority areas for nature conservation contribute to the protection of open spaces because they exclude uses that are incompatible with nature conservation. This reduces threats to harbour porpoises in important feeding and breeding grounds. The establishment of these areas will not have any negative impact for harbour seals and grey seals, either.

Based on the above statements and the presentations in Chapter 3, the SEA concludes that the designation 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 with not implementing the plan.

4.2.6 Seabirds and resting birds

The general impacts of offshore wind energy on seabirds and resting birds are described in Chapter 3.2.5 .

Priority areas are sometimes defined in locations where offshore wind farm projects have already been implemented or have a concrete implementation status (EN1 to EN3, EN6 to EN8). Other priority areas where no projects have yet been implemented are located in a spatial context with already developed areas (EN9 to EN13) so that a comparable function as resting and feeding habitat can be assumed for these areas, taking into consideration the respective species-specific habitat requirements, spatial and temporal distribution patterns, and species-specific behaviour towards OWF (cf Chapters 2.9.2.5 and 3.2.5). The designation of reservation areas for wind energy takes into consideration, among other things, areas such as EN4 and EN5 for which conflicts of use have already been identified in SDP 2019 and SDP 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 divers. 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 1 January 2030. Therefore, the extent to which avoidance and mitigation measures must be applied to the specific installations applied for must be examined in the individual procedure.

The definition 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 provisions on wind energy may lead to a spatial concentration of shipping traffic in some parts of the EEZ due to the navigation regulations in force. However, it can be assumed that this densification is taking place in traffic areas that are already experiencing 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, white-winged scoter, and red-breasted mergansers are among the most sensitive species to shipping traffic. The most common reaction is to take off, even if the flight distances vary considerably.

According to current state of knowledge, the designations of the ROP for wind energy in areas EN1 to EN12 do not have any additional or significant impacts on the protected asset seabirds and resting birds. For the designations for the priority area EN13 and the conditional priority area EN13-North, this assessment can be made only in consideration of the overall plan assessment of the ROP (cf Chapter 7).

4.2.7 Migratory birds

The general impacts of offshore wind energy on migratory birds have been described in Chapter 3.2.6 .

By defining priority and reserved areas in a spatial context and securing open space in the nature reserves, barrier effects and collision risks in important food and resting habitats are reduced.

On the basis of the current state of knowledge, it is possible to rule out with the necessary certainty any significant effects of the provisions on migratory birds, particularly in comparison with the non-implementation of the spatial development 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 is currently no evidence that the spatial planning regulations have a significant impact on bats. By defining priority and reserved areas in a spatial context and securing open space in nature conservation areas, barrier effects are reduced and important habitats are protected.

4.2.9 Climate

No significant negative impacts on the climate are expected as a result of the designations on offshore wind energy.

The CO_2 savings associated with the expansion of offshore wind energy (cf Chapter 1.8) can be expected to have positive impacts 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 reservation areas identified by the ROP will have impacts on the protected asset landscape because 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. Because of the considerable distance of the planned areas from the North Sea coast of more than 30 km, the installations will be perceptible from land to only a very limited extent (Hasløv & Kjærsgaard 2000) and only in good visibility conditions. This also applies with regard to night-time safety lighting. Because of subjective perceptions as well as the basic attitude of the observer towards offshore wind energy, the vertical structures – which are untypical for a marine and coastal landscape – can be perceived partly as disturbing but partly also as technically interesting. In any case, they cause a change in the landscape, and the character of the area is modified.

Beyond the coast, the visual impairment of the landscape changes with greater proximity to the offshore areas. The type of use is decisive here. Thus, the value of the landscape plays a subordinate role in industrial or transport use. For recreational uses, such as water sports and tourism, the landscape is of great importance. However, direct use for recreation and leisure by pleasure boats and tourist vessels is only sporadic 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 installations in the German EEZ on the coast can be classified as minor. The designations of the ROP can minimise the space requirements for the expansion of offshore wind energy through coordinated and harmonised overall planning and thus – compared with non-implementation of the plan – also reduce the impacts on the protected asset landscape.

For the cables, negative impacts on the landscape can be ruled out due to their installation 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 designations can be ruled out with the necessary certainty.

4.3 Lines

The ROP defines the reservation areas lines LN1 to LN15. Lines within the meaning of the ROP include pipelines and submarine cables. Submarine cables include cross-border power cables and connecting cables for wind farms as well as data cables. Farm-internal submarine cables are not included in this definition. In addition, the ROP sets the objective of routing subsea cables and pipelines at the transition to the territorial waters through the boundary corridors GN1 to GN7 as well as at the transition to bordering states through boundary corridors GN8 to GN19.

4.3.1 Seabed

The impacts of the construction and operation of lines and submarine cables on the seabed described in Chapter 3.3.1 occur independently of the designations of the ROP.

The ROP makes statements regarding the reduction of pollution of the marine environment to be sought by taking into consideration best environmental practices 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 cables, damage to or destruction of biotopes must be avoided in accordance with Article 30 BNatSchG.

In addition, the definition of reserved areas for cables in the spatial development plan means that interactions among uses and cumulative effects on protected assets can be better assessed and forecast in existing and, above all, future planning.

Therefore, no significant negative impacts are to be expected with regard to the protected asset seabed as a result of the designations for lines/submarine cables in the ROP. Rather, adverse impacts are avoided compared to non-implementation of the plan because the designations of the plan aim to minimise the use of the seabed through the reduction of pipeline routes and the minimisation of crossing constructions.

4.3.2 Benthos

Lines may have impacts on the macrozoobenthos. These impacts apply equally to all designated reservation areas for lines.

<u>Construction-related:</u> Possible effects 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 as a result of the careful laying of the submarine cable systems and pipelines by means of flushing-in procedures or laying of pipelines.

In the event of a stock decline as a result of a natural or anthropogenic disturbance (e.g. flushing-in of cables), enough potential organisms remain in the overall system for recolonisation (KNUST et al. 2003). The linear character of submarine cable systems and pipelines favours repopulation from undisturbed peripheral areas.

Turbidity plumes are caused by the disturbance of the sediment during the flushing of the cable system or the laying of pipes. The dispersion of sediment particles depends to a large extent on the content of fine particles and the hydrographic situation (especially sea state, current) (HERRMANN & KRAUSE 2000). Due to the predominant sedimentary composition in the North Sea EEZ, most of the sediment released will settle directly at the construction site or in its immediate vicinity.

Thus, according to current knowledge, the impairments during the construction phase remain small-scale and usually short-term.

Benthic organisms can also be adversely affected in the short term and on a small scale by the release of nutrients and pollutants associated with the resuspension of sediment particles. The oxygen content can decrease when organic substances are brought into solution (HERRMANN and 2000).

The impact is generally considered to be small, as the laying of cables is limited in time and space and pollution levels are relatively low in the EEZ area. In addition, waves and currents cause a rapid dilution of any increases in the concentration of nutrients and pollutants that may occur.

The potential effects of any repair work that may become necessary are comparable to the possible construction-related effects.

Installation-related impacts: In the area of overlying pipelines or possible crossings the disturbances are permanent, but also small-scale. Necessary crossings are secured with a stone fill, which permanently represents a hard substrate that is foreign to the location. The hard substrate that is foreign to the location provides new habitats for benthic organisms.

Due to operational conditions, heating of even the uppermost sediment layer of the seabed can occur directly above current-carrying cable systems, which can reduce the winter mortality of the infauna and lead to a change in 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 effects on the benthos from cable-induced sediment warming are to be expected, provided that a sufficient laying depth is maintained and state-of-the-art cable configurations are used. Electric and electromagnetic fields are also not expected to have significant impacts on the macrozoobenthos.

If the installation depth is sufficient and taking into account the fact that the effects will occur on a 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 effects are small-scale and mostly short-term.

For pipelines, the chemicals resulting from an impression test can be discharged into the water body at a high dilution. To protect the pipeline from external corrosion, sacrificial anodes made of zinc and aluminium are attached at regular intervals. These anodes are dissolved only in small quantities and released into the water column. Because of the very high dilution, they are present only in trace concentrations; in the water, they are adsorbed to sinking or resuspended sediment particles and sediment on the seabed.

4.3.3 Biotopes

Lines may have impacts on biotopes. These impacts apply equally to all designated reservation areas for lines.

Because of construction, possible impacts of subsea cables and pipelines on the protected asset biotopes may result from a direct claim on protected biotopes, a possible overlap as a result of the sedimentation of released material, and potential habitat changes. Direct use of protected biotopes is avoided as far as possible through the planning of the line systems. In addition, protected biotopes under Article 30 BNatSchG must be given special consideration in the specific approval procedure and avoided as far as possible in the course of fine routing.

Due to the predominant sediment composition, impairments caused by overburdening are likely to be small-scale, as the released sediment will settle quickly.

System-related permanent habitat changes are limited to the area where pipelines rest on the seabed and the immediate area of rock fills that become necessary in case of crossings. The pipelines and the rock fills permanently represent a hard substrate that is not native to the site, even in areas with a predominantly homogeneous sandy seabed.

Known occurrences of protected biotopes according to Section 30 BNatSchG shall be avoided as far as possible. Because of the lack of reliable data at the level of this SEA, it is not possible to assess whether the marine biotopes considered in Section 30, paragraph 1, No. 6 BNatSchG actually occur in the area of the planned transmission lines and, if so, whether they will be adversely affected because there is no detailed area-wide biotope mapping for the EEZ of the North Sea to date.

It is generally assumed that biotopes protected under Article 30 of the Federal Nature Conservation Act which have a specific sensitivity to the laying of pipelines, especially reefs, occur only in small areas and at specific points and can be bypassed by fine routing. If it is not possible to bypass these strictly protected biotopes or FFH-LRT, e.g. because the occurrences are more extensive, significant impairment of these legally protected biotopes cannot be ruled out. In the specific individual procedure, it must be examined, on the basis of available data from the route surveys, whether the affected area is so large that significant impairment exists.

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 consideration the gentlest possible cable laying procedure, the bundling of lines, and optimised routing. The spatial planning area designations for the lines are therefore not expected to have any additional or significant impacts on fish fauna.

4.3.5 Marine mammals

The spatial development plan makes statements regarding the reduction of the burden on the marine environment by taking into account best environmental practice in accordance with the OSPAR and HELCOM Conventions and the current state of the art in laying, operating, maintaining and dismantling submarine pipelines. This can reduce adverse impacts on the marine environment.

The identification of areas for pipelines in the spatial development plan means that interactions between uses and cumulative effects on biological assets can be better assessed and forecast in existing and, above all, future planning.

4.3.6 Avifauna

The general impacts of lines on avifauna are described in Chapters 3.3.5 and 3.3.6. The impacts are only temporary and local.

Significant effects of the spatial planning regulations on avifauna can be ruled out with the necessary certainty.

4.3.7 Bats and bat migration

The general impacts of lines on bats are described in Chapter 3.3.7. The impacts are only temporary and local.

Significant impacts of the spatial planning designations can be ruled out with the necessary certainty.

4.3.8 Cultural assets and other material assets

The designations for the planning, construction, and operation of wind turbines and 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 sub-seabed investigations and seabed 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 lines on cultural assets and other material assets are described in Chapter 3.3.9. Significant impacts of the spatial planning designations can be ruled out with the necessary certainty.

4.4 Raw material extraction

As a principle of the spatial planning, the areas SKN1 and SKN2 are designated as reserved areas for sand and gravel extraction, while the areas KWN1 to KWN5 are designated as reserved areas for hydrocarbons.

4.4.1 Seabed

The general provisions of the ROP regarding the extraction of raw materials, such as, for example, the use of the soil, have a fundamentally positive impact on the soil as a protected resource:

- Concerted extraction of raw material deposits using as little space as possible,
- Reduce the impact on the environment by taking into account the best environmental practice under the OSPAR and Helsinki Conventions in the exploration and extraction of raw materials,
- Project-related monitoring to ensure environmentally sound extraction of raw materials,
- Avoiding damage to sandbanks, reefs and submarine structures caused by gas leaks.

As a result of the spatial designations in the ROP, 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 designation of the reservation areas for the extraction of hydrocarbons, there are no additional impacts for the protected asset seabed.

With regard to sand and gravel extraction, the ROP designates the reservation areas SKN1 and SKN2, which are located within the marine protected area “Sylter Außenriff – Östliche Deutsche Bucht”. As described in Chapter 3.4.1, in accordance with monitoring data, the current extraction activities in the SKN1 reservation area (permit field OAM III) do not cause any significant adverse effects on the original substrates and the legally protected biotopes “reefs” and “species-rich gravel, coarse sand and shell layers”. For their protection and conservation, locally adapted ancillary provisions were created in the individual procedure. The seabed will therefore be stressed by the impacts of current raw material extraction in the OAM III permit field but will not undergo any significant changes. The sedimentological conditions in the reservation 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 implementing suitable monitoring investigations – no significant adverse effects on the protected asset seabed are to be expected as a result of the designation of reservation areas SKN1 and SKN2.

4.4.2 Benthos and biotopes

The general impacts of raw materials extraction are described in Section 3.4.2. With regard to the designation of areas KWN1 to KWN5 for hydrocarbon extraction, there are no additional impacts.

With regard to the designation of the areas SKN1 and SKN2 as reserved areas for sand and gravel extraction, their location within the nature reserve "Sylt Outer Reef – Eastern German Bight" must be taken into account.

Based on 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 adverse effects on 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 impacts of raw material extraction on fish fauna can be found in in Chapter 3.4.3.

The exact formulation of the spatial planning designations for raw material extraction takes place in the mining law procedure. The designations are redrawings of already approved or existing activities.

Because of overlaps of the raw material extraction areas with the inhabitation, wintering, and spawning grounds 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, is lacking (IFAÖ 2019a). These impacts are currently present even if the plan is not implemented. Significant adverse effects on fish fauna as a result of the zoning of the ROP can thus be ruled out with the necessary degree of certainty.

According to the current state of 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 definitions of the reservation areas KWN1, KWN2, and KWN3 for hydrocarbon extraction in Zones 4 and 5 are the corresponding permits according to Section 7 BBergG or licences according to Section 8 BbergG (cf Chapter 3.4, Designations on raw material extraction in ROP 2021). The specifications are, therefore, records of already approved or existing activities. The incorporation of the raw material extraction areas into the spatial development plan means that, in existing and, above all, in future planning, the interactions between the uses and cumulative impacts on biological assets can be better assessed and forecast.

Based on the above statements and the presentations in Chapter 3.4.4, the SEA concludes that no significant impacts on marine mammals are to be expected, but rather that adverse effects will be avoided compared to not implementing the plan.

4.4.5 Seabirds and resting birds

The basis for defining the reservation areas KWN1 to KWN5 for hydrocarbon extraction are the permit fields NE3-0002-01, NE3-0001-01 and NE3-0005-01 according to Section 7 BbergG and the German North Sea permit A6/B4 according to Section 8 BBergG (cf Chapter 3.4, Designations on raw material extraction in ROP 2021). The specifications are based on already licensed or existing activities. The spatial planning provisions are, therefore, not expected to increase the intensity of use in the areas. Significant impacts of the designations can be excluded with the necessary certainty.

The areas SKN1 and SKN2 reserved for sand and gravel extraction (with the exception of a part of the reserved area SKN2) are located within the nature reserve " Sylt Outer Reef - Eastern German Bight ". The SKN1 reserved area is entirely within sub-area II of the nature reserve and thus within the "Eastern German Bight" bird sanctuary. Both reserve areas are also completely within the main concentration area of loons in spring.

In the status description and assessment of the nature conservation areas in the North Sea EEZ, the impacts of sand and gravel extraction in the OAM III permit area (SKN1) on seabird species or species groups protected in the bird reserve were predominantly rated as "negligible" (BfN 2017). The low level of sand and gravel extraction in previous years had only minor impacts on loons and aukes. This also corresponds to a current expert assessment within the framework of the FFH impact assessment of the OAM III permit field* (IFAÖ 2019). Furthermore, there are no findings on fundamental changes in the sediment structure resulting from 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 spatial plan contains the principle (cf Principle 2.4 (3)) that sand and gravel extraction in the priority area for divers should be avoided as far as possible during the period from 1 March to 15 May.

Significant impacts of the designations can be excluded with the necessary certainty.

4.4.6 Migratory birds

Significant effects from the spatial planning definitions of reserved areas for sand and gravel extraction and hydrocarbon extraction and the priority area for hydrocarbon extraction can be excluded with the necessary certainty.

4.4.7 Cultural assets and other material assets

The general impacts of the spatial planning designations for sand and gravel extraction and the extraction of hydrocarbons on cultural assets and other material assets are described in Chapter 3.4.8. Considerable impacts of the spatial planning designations can be excluded with the necessary certainty, taking into consideration Principle 3 on general requirements for economic uses.

4.5 Fishing and aquaculture

The ROP contains a general designation for aquaculture.

The general impacts of aquaculture on the various protected assets are described in Chapter 3.5.

Because the designation of aquaculture is not a spatial but rather only a general designation, both the future location and the specific design of the use are currently unknown. In order to be able to exclude a significant adverse effect on the marine environment, the following prerequisites must be met, and their fulfilment must be checked in downstream plans or at the project level.

- Inputs of nutrients and excreta limited to a tolerable level
- No inputs of medicines/antibiotics
- Aquaculture limited to native species
- No use of organisms from wild stocks
- Avoidance of negative impacts on wildlife stocks
- Any deterrence measures limited to a tolerable level.

The ROP contains a designation for Norway lobster fishing in the form of the FiN1 reservation area. The assessment of the potential impacts of the designation on fishing is presented in the following chapters on a conservation-asset-specific basis.

4.5.1 Seabed

The adversely affect on the seabed with regard to the use fishing is presented in Chapter 3.5.1 . Because the planned reservation area for Norway lobster fishing (FiN1) has been considered a traditional main area for Norway lobster for decades, no further significant impacts on the protected asset seabed are to be expected with regard to this ROP designation.

In order to be able to exclude a significant adverse effect of aquaculture on the protected asset seabed, the inputs of nutrients and excreta products should be kept to a minimum. The input of medicines, especially antibiotics, should be avoided.

4.5.2 Benthos and biotopes

With regard to the use of fishing, there are no further specific impacts of the designations of the ROP compared with the general effects of the use described in Chapter 3.5.2.

Increases in fishing effort because of the designation as a reservation area are not forecast. Thus, significant impacts on benthic communities and biotopes can be ruled out on the basis of the designations of the ROP on fishing.

4.5.3 Fish

The intensity and general impacts of fishing on fish fauna are described in Chapters 2.7.3 and 3.5.3.

The designated reservation area for Norway lobster fishing does not change the intensity of fishing in the area. The spatial planning designations for fishing 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 Chapter 3.5.4. The designation of the FinN reservation area for Norway lobster fishing 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 fishing, there are no further impacts of the designations of the ROP compared with the general impacts of use described in Chapter 3.5.5 and 3.5.6. The designation of the FiN1 reserve area for Norway lobster fisheries is not expected to lead to an increase in fishing activity in this area.

4.5.6 Cultural assets and other material assets

The general impacts of the spatial planning designations for fishing on cultural assets and other material assets are described in Chapter 3.5.7. Considerable impacts of the spatial planning designations can be excluded with the necessary certainty, taking into consideration Principle 3 on general requirements for economic uses.

4.6 Marine research

For marine research, in particular the fisheries research activities of the Thuenen-Institute for Sea Fisheries, the GSBTS boxes of the Thuenen-Institute for Sea Fisheries have been designated as research reserve areas FoN1 to FoN3 in the North Sea.

The designation is made to safeguard existing long-term research series in the field of fishery research. This is to keep these areas free from uses that could devalue the long-term research series.

The results of marine scientific research are to be continuously recorded in order to explain ecosystem interrelationships as comprehensively as possible and thus create an important basis for sustainable development in the EEZ.

Because this is a question of safeguarding the existing stock, the area designations have no further impacts on the protected assets and the marine environment as a whole compared with the current situation and the zero alternative.

4.6.1 Seabed

The designations of the ROP 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 provisions of the Spatial Plan for marine research use can thus be ruled out.

4.6.2 Benthos and biotopes

With regard to the use of marine research, there are no further specific impacts of the designations of the ROP compared with the general effects of the use described in Chapter 3.6.2. Significant impacts on benthic communities and biotopes because of the designations of the ROP on marine research can therefore be ruled out.

4.6.3 Fish

Compared with the impacts on fish fauna described in Chapter 3.6.3, the spatial planning designations 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 among uses and cumulative impacts on biological assets can be better assessed in existing and, above all, future planning.

Based on the above statements and the presentations in Chapter 3.6.4, it can be concluded 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 spatial plan but rather that adverse impacts are avoided in comparison with non-implementation of the plan.

4.6.5 Avifauna

With regard to marine research, there are no further specific impacts of the designations of the ROP compared with the general effects of the use described in Chapter 3.6.5. Significant impacts on seabirds and resting birds as well as migratory birds because of the designations of the ROP on marine research can be ruled out with the necessary degree of certainty.

4.6.6 Cultural assets and other material assets

The general impacts of the spatial planning designations for marine research on cultural assets and other material assets are described in Chapter 3.6.7. Considerable impacts of the spatial planning designations can be excluded with the necessary certainty, taking into consideration Principle 2 on scientific uses.

4.7 Protection and improvement of the marine environment

The National Marine Protected Areas Borkum Riffgrund, Doggerbank, Sylt Outer Reef – Eastern German Bight in the North Sea EEZ are designated as priority areas for nature conservation in accordance with their conservation objectives.

The “main concentration area of divers” defined in the BMU position paper of 2009 is identified as a priority area for divers.

The main distribution area of harbour porpoises in summer (in accordance with BMU's 2013 noise abatement concept) is defined as the temporary reserve area "Harbour porpoises (May to August)".

By designating the temporary exclusion of installations, the construction of installations above the water surface is excluded on this site.

The target of climate neutrality in Germany, which has been brought forward to 2045, will require an increased expansion of renewable energies. Therefore, further sites for offshore wind energy use are also needed in the EEZ. The federal government will therefore commission studies for the impact assessment of wind power use on Doggerbank 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 which have an important ecological function for specific species – the main concentration area of loons and the main distribution area of harbour porpoises – as reserved areas provides special protection for the species group of loons and harbour porpoise, which are sensitive to disturbance. The spatial plan thus contributes to achieving the objectives of the MSFD.

4.7.1 Seabed

The spatial development plan reinforces nature conservation in the German EEZ by defining priority areas for nature conservation. This supports the expected positive effects of management measures for marine protected areas on the seabed protected asset.

4.7.2 Benthos and biotopes

The designation of the designated nature conservation areas of the North Sea EEZ as nature conservation priority areas supports the positive effects on benthic communities and biotopes that can be expected on the basis of appropriate management measures for 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 Appendix 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 shell layers, and the function of these habitats as a regeneration area for benthic communities.

4.7.3 Fish

The general impacts of nature conservation areas on the fish community is described in Chapter 3.7.3.

The designation of nature reserves as priority areas in the EEZ could have a positive impact on the fish fauna. In particular, marine protected areas could increase the biodiversity and condition of the fish zone and counteract the overexploitation of fish stocks.

4.7.4 Marine mammals

The harbour porpoise is one of the protected species in all three priority areas of nature conservation. In addition, the plan defines the main concentration area identified as part of BMU's noise abatement concept (2013) as the reserve area for harbour porpoises during the sensitive period from 1 May to 31 August inclusive. The designation of wind energy priority areas exclusively outside priority areas for nature conservation leads to the avoidance and mitigation of negative impacts on the population of harbour porpoise in the German North Sea EEZ. The designation of the porpoise priority area will also protect important habitats during the rearing season.

As a result, the nature conservation provisions have a positive impact on the conservation status of the harbour porpoise population.

4.7.5 Avifauna

Among other things, the spatial development plan defines the nature reserve "Sylt Outer Reef – Eastern German Bight" with the bird sanctuary in sub-area II of the complex area as a nature conservation priority area. This provides special protection for the habitat of specially protected species and regularly occurring migratory bird species. By establishing priority and reserved areas for wind energy exclusively outside priority areas of nature conservation, the impact of offshore wind energy on protected and other bird species and their habitat, such as habitat loss and collision risks, will be reduced.

The main concentration area of divers is additionally designated as a priority area for divers (cf ROP Objective (1) Chapter 2.4 Nature conservation). The designation of the main concentration area of divers, which is larger in terms of area, as a priority area encompassing Sub-area II of the nature conservation area “Sylter Außenriff – Östliche Deutsche Bucht” may also have a positive impact on other species protected in the nature conservation area or bird conservation area and their feeding and resting grounds. In addition, military use should interfere as little as possible with the conservation purpose of the diver priority area. From 1 March to 15 May of a given year, it applies that there should be no adverse effects from sand and gravel extraction in the priority area for divers and that the Federal Armed Forces authorities and the competent nature conservation authority should reach agreement on military use (cf ROP Principle (3) Chapter 2.4 Nature conservation). This gives additional consideration to the protection of the diver species group, which is sensitive to disturbance and its particularly important habitat in the EEZ of the North Sea. The designation of the reservation areas for divers (StN1 to StN3) simultaneously takes account of the sustainable use of reservation areas EN4 and EN5.

In addition, by excluding installations above the water surface*, designation 2.4 (5) serves to implement measures to secure the coherence of the Natura 2000 network (coherence measures) with regard to adverse effects emanating from existing wind turbines in the priority or reservation area for divers. In order to enable nature conservation sectoral planning to develop its own compensatory regulation in this respect, the temporary designation 2.4 (5) is made as spatial planning support; through this, the area in question is temporarily protected from conflicting uses. This also supports the protection of divers.

Overall, the spatial planning designations on nature conservation in the EEZ have exclusively positive impacts on seabird and resting bird species as well as migratory birds.

4.8 National and allied defence

In the EEZ of the North Sea, the reservation areas for national and alliance defence are designated.

The reservation areas are used for training, exercise, and testing activities of the navy and air force of the German Federal Armed Forces and alliance partners.

With regard to national and allied defence, there are no further specific impacts of the designations of the ROP compared with the general effects of use on the various protected assets described in Chapter 3. Because of the designations of the ROP on national and alliance defence, significant impacts 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 expected as a result of the designations of the ROP.

4.9.2 Leisure activities

Recreational activities in the EEZ are mainly carried out in private small motor and sailing boats. In contrast to areas near the coast, relatively low frequencies and environmental pollution are assumed. No direct impact on the marine environment is expected as a result of the designations of the ROP.

4.10 Interrelationships

In general, impacts on a protected asset lead to various consequences and interrelationships between the protected assets. Thus, impacts on the seabed or the water body usually also have consequential effects on the biotic protected assets 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 assets exists via the food chains. These interrelationships between the different protected goods and possible impacts on biodiversity are presented in detail for the respective protected assets.

Sediment shifting 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. As a result, the feeding conditions for benthos-eating fish and for fish-eating seabirds and harbour porpoises also change temporarily and locally (decrease in the supply of available food). However, because of the mobility of the species and the temporal and spatial limitation of sediment redistribution and turbidity plumes, significant adverse effects on the biotic protected assets and thus on the existing interrelationships between them can be excluded with the necessary certainty.

Noise emissions

The installation of facilities can lead to temporary escape reactions and avoidance of the area by marine mammals, some fish species and seabird species. Great seagulls, on the other hand, are attracted by the construction activities. On the other hand, avoidance by seabirds sensitive to disturbance would reduce the risk of bird strikes.

Land use

The installation of foundations will result in a local deprivation of settlement area for the benthic ecosystem. This may lead to a potential deterioration of the food base for the following fish, birds, and marine mammals within the food pyramid. However, benthos-eating seabirds in deeper water areas are not affected by the loss of foraging area due to land sealing, as the water is too deep for effective food acquisition.

Placement of artificial hard substrate

The introduction of an artificial or off-site hard substrate (e.g. foundations, cable crossing structures) leads to a change in seabed and sediment conditions locally. As a result, the composition of the macrozoobenthos may change. According to KNUST et al. (2003), the introduction of artificial hard substrate into sandy seabeds leads to the settlement of additional species. These species will most likely be recruited from natural hard substrate habitats, such as superficial boulder clay and stones.

Thus, the risk of negative impacts on benthic sandy seabed communities by non-native species is low. However, settlement areas for sandy soil fauna are lost in these places. By changing the species composition of the macrozoobenthos community, the food base of the fish community at the site can be influenced (bottom-up regulation).

Certain fish species could be attracted, which in turn could increase the feeding pressure on the benthos by predation and thus shape the dominance relationships by selecting certain species (top-down regulation).

Prohibition of use and driving

Within and around the wind farms and platforms there is a fishing ban. Restrictions on fishing can lead to an increase in the stock of both target and unused fish species, and a shift in the length spectrum of these fish species is also conceivable. In the event of an increase in fish stocks, an enrichment of the food supply for marine mammals can be expected. Furthermore, it is expected that a macrozoobenthic community undisturbed by fishing activity will develop. This could mean that the diversity of the community of species will increase, giving sensitive and long-lived species of the current epifauna and infauna better chances of survival and developing stable stocks.

Because of the variability of the habitat, interrelationships can only be described in a very imprecise manner overall. In principle, it can be stated that, at present, no effects on existing interactions that could result in a threat to the marine environment are discernible as a result of the Spatial Plan. Therefore, it must be concluded for the SEA that, according to the current state of knowledge, no significant impacts due to interactions on the marine environment are to be expected from the provisions in the spatial development plan, but rather that, compared with non-implementation of the plan, adverse impacts can be avoided.

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 reservation areas for transmission lines on seabed, benthos, and biotopes will occur exclusively during the construction period (e.g. formation of turbidity plumes, sediment rearrangement) and in a spatially limited area. Because of the gradual implementation of the construction projects, construction-related cumulative environmental impacts are not very likely. Possible cumulative impacts on the seabed, which could also have a direct impact on the protected asset benthos and specially protected biotopes, result from the permanent direct area use of the foundations of the installations and from the cables laid. The individual impacts are basically small-scale and local.

In the area where lines are laid, the adverse effect on sediment and benthic organisms will essentially be temporary. In the case of crossing particularly sensitive biotopes such as reefs or species-rich gravel, coarse sand, and fish grounds, permanent adverse effect would have to be assumed.

Please refer to the environmental report for the SDP 2019 and SDP 2020 for a balance of area use. There, an estimate of the direct area use by wind energy and power cables is made using model assumptions.

No statement can be made on the use of specially protected biotopes according to Section 30 BNatSchG because of the lack of a reliable scientific basis. 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 claim on the seabed and thus the habitat of the organisms settled there, plant foundations, overlying pipelines, and necessary crossing constructions lead to an additional supply of hard substrate. As a result, non-native hard substrate-loving species can colonise and change the species composition. This effect can lead to cumulative effects because of the construction of multiple offshore structures, piping or riprap in pipeline crossing areas. The hard substrate introduced also causes the loss of habitat for the benthic fauna adapted to soft bottoms. However, because both the grid infrastructure and the wind farms will result in an area use in the ‰ range, no significant adverse effects that would pose a threat to the marine environment in terms of the seabed and benthos are to be expected.

4.11.2 Fish

The impact on the fish fauna caused by the provisions is probably most strongly determined by the realisation of an initial 20 GW of wind energy in the reserved areas of the North and Baltic Seas. Here, the impacts of the OWFs focus on the regularly ordered closure of the area to fishing as well as the change in habitat and its interrelationship.

The anticipated fishery-free zones within the wind farm areas could have a positive impact on fish populations by eliminating negative fishing effects such as disturbance or destruction of the seabed as well as catch and by-catch of many species. Because of the lack of fishing pressure, the age structure of the fish fauna could develop again towards a more natural distribution 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 growth of wind turbines with sessile invertebrates could favour benthophagous species and make a larger and more diverse food source accessible to 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 impacts to the population level of fish.

Furthermore, the wind farms of the southern North Sea could have an additive effect and beyond their immediate location in that the mass and measurable production of plankton could be dispersed by currents and thus influence the qualitative and quantitative composition of the 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; species with habitat preferences that differ from those of the established species (e.g. reef dwellers) could find more favourable living conditions and thus occur more frequently. In the Danish wind farm Horns Rev, 7 years after its construction, a horizontal gradient in the occurrence of hartsubrate-affected species was found between the surrounding sand areas and near the turbine foundations: Cliff perch (Ctenolabrus rupestris), eelpout (Zoarces viviparous), and lumpfish (Cyclopterus lumpus) were much more common near the wind turbine foundations than on the surrounding sandy areas (LEONHARD et al. 2011). Cumulative effects resulting from a major expansion of offshore wind energy could include

- an increase in the number of older individuals,
- better conditions for the fish because of 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 zones,
- 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 (also referred to as density limitation). It cannot be ruled out that local density limitation sets in within individual wind farms 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. The impacts of changes in fish fauna on other elements of the food web – both below and above their trophic level – cannot be predicted given the current state of knowledge.

Together with the designations 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 effects on marine mammals, in particular harbour porpoises, may occur mainly due to noise exposure during the installation of deep foundations. For example, marine mammals can be significantly affected by the fact that – if pile driving is carried out simultaneously at different locations within the EEZ – there is not enough equivalent habitat available to avoid and retreat to.

The realisation of offshore wind farms and platforms to date has been relatively slow and gradual. Between 2009 and 2018, pile driving work took place at twenty wind farms and eight converter platforms in the German North Sea EEZ. Since 2011, all pile driving work 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 mitigation 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 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 4 was it necessary to coordinate the pile driving work, including the deterrence measures.

The evaluation of the noise results with regard to noise propagation and the possibly resulting accumulation has shown that the propagation of impulsive noise is strongly limited when effective noise-minimising measures are applied (Brandt et al. 2018, Dähne et al., 2017).

Cumulative impacts of the plan on the population of harbour porpoise are considered in accordance with the requirements of the noise abatement concept of the BMU of 2013. In order to avoid and mitigate cumulative impacts on the harbour porpoise population in the German EEZ, the orders of the downstream approval procedure shall specify a restriction of the sound exposure of habitats to maximum permitted proportions of the EEZ and nature conservation areas. According to this, the propagation of noise emissions may not exceed defined areas of the German EEZ and nature conservation areas. This ensures that sufficient high-quality habitats are available for the animals to escape at all times. The arrangement primarily serves to protect marine habitats by preventing and minimising disturbances caused by impulsive sound input.

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 sensitive period of the harbour porpoise 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 “Sylter Außenriff – Östliche Deutsche Bucht” 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.

Defining the protected area for harbour porpoises means that the standards for the protection of impulsive noise emissions applicable to projects in the “Sylt Outer Reef – Eastern German Bight” protected area will also apply in future to projects in and around the protected area as part of subordinate approval procedures.

The area reserved for harbour porpoises during the summer months includes the “Sylt Outer Reef” protected area and its immediate surroundings. Pile driving operations with the potential to cause disturbance due to noise in the main concentration area of harbour porpoises during the sensitive season are coordinated in such a way that the proportion of the area affected remains below 1% at all times. In accordance with the noise abatement concept of the BMU (2013), all pile driving activities are coordinated with the objective of always keeping sufficient escape routes free in the protected areas, in equivalent habitats, and in the entire German EEZ.

As a result, it is concluded that implementation of the plan will result in 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

Among the uses taken into account in the spatial development plan, the use of offshore wind energy by vertical structures such as platforms or offshore wind turbines, in particular, can have different impacts on seabirds and resting birds, such as habitat loss, an increased risk of collision or a chasing and disturbance effect. These effects are considered location- and project-specifically in the environmental impact assessment and are monitored in the subsequent monitoring of the erection and operation phase of offshore wind farm projects. For sea and resting birds, habitat loss resulting from cumulative impacts of several structures or offshore wind farms can be particularly significant. Therefore, the cumulative effects of offshore wind energy on seabirds and resting birds are discussed below.

In order to assess the significance of cumulative effects on seabirds and resting birds, any impacts need to be assessed on a species-specific basis. In particular, species of Appendix I of the Birds Directive, species of sub-area II of the "Sylter Außenriff – Östliche Deutsche Bucht" nature conservation area, and such species for which an avoidance behaviour towards structures has already been determined are to be considered with regard to cumulative impacts.

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

The main concentration area takes into consideration the period that is particularly important for the species: the spring. The main concentration area was designated in 2009 on the basis of the data available at the time: the main concentration area was home to around 66% of the German North Sea diver (diver) population and around 83% of the EEZ population in spring, and is therefore, among other things, of particular importance in terms of population biology (BMU 2009) and an important functional component of the marine environment with regard to seabirds and resting birds. Against the background of current stock assessments, the importance of the main concentration area for divers in the German North Sea and within the EEZ has further increased (SCHWEMMER et al. 2019).

The current results from the operational monitoring of offshore wind farms and from research projects, some of which used investigation methods independent of the standardised monitoring in accordance with Standard Investigation Concept (StUK) (e.g. telemetry study within the framework of the DIVER project), unanimously 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 from an FTZ study were presented at the BSH's Marine Environment Symposium in 2018. The evaluations have been published (GARTHE et al. 2018, SCHWEMMER et al. 2019). The cumulative consideration of the avoidance behaviour of divers compared with 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). The statistically significant decrease in abundance is not due to total avoidance but rather to partial avoidance with increasing densities of divers up to a distance of 10 km from a wind farm. The calculated total habitat loss of 5.5 km is used to quantify the habitat loss in analogy to the former shooing distance of 2 km. It is based on the purely statistical assumption that there are no divers within 5.5 km of an offshore wind farm. A further cross-project study on the occurrence and distribution of as well as effects of offshore wind farm projects on divers in the German North Sea commissioned by the BWO provided comparable results for all implemented wind farm projects, with a significant avoided distance of 10 km and a calculated total habitat loss of approx. 5 km. 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 and research projects consistently show that the avoidance behaviour of divers towards offshore wind farms is far more pronounced than previously assumed. A stock calculation for the main concentration area within the scope of the sea diver study of the FTZ commissioned by BfN and BSH showed an increase in the red-throated diver population for the period from 2002 to 2012, which has remained at a relatively constant high level since 2012. However, for the entire German North Sea, the sub-areas of which are of varying local importance as habitats for divers, a decrease in the population of red-throated divers has been observed since 2012 (observation period until 2017) (SCHWEMMER et al. 2019). The study commissioned by the BWO yields qualitatively and quantitatively comparable stock figures and stock trends for the main concentration area and the German North Sea. Differences can be attributed to different methodologies for stock calculation as well as modified data bases.

Both studies confirm the overall high and special functional importance of the main concentration area as a habitat for divers in the German North Sea (SCHWEMMER et al. 2019, BIOCONSULT SH et al. 2020). This is especially true against the background of the pronounced avoidance behaviour and the accompanying habitat loss.

The main concentration area is a particularly important component of the marine environment with regard to seabirds and resting birds, especially the species group divers. The spatial planning designations 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 OWF in the EEZ of the North Sea. The designation of Areas EN4 and EN5 within the main concentration area as reservation areas for offshore wind energy takes up the review of Areas N-4 and N-5 for subsequent use in the SDP 2019 (BSH 2019) and SDP 2020 (BSH 2020a) at the spatial planning level. In addition, military use should interfere as little as possible with the conservation purpose of the diver priority area. From 1 March to 15 May of a given year, it applies that there should be no adverse effects from sand and gravel extraction in the priority area for divers and that the Federal Armed Forces authorities and the competent nature conservation authority should reach agreement on military use (cf ROP Principle (3) Chapter 2.4 Nature conservation). This gives additional consideration to the protection of the diver species group, which is sensitive to disturbance and its particularly important habitat in the EEZ of the North Sea. The designation of the reservation areas for divers (StN1 to StN3) simultaneously takes account of the sustainable use of reservation 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 installations applied for.

The definitions of other applications are located outside the main diver concentration area, in areas of lesser importance for divers, and/or that refer to applications where impact is mostly temporary and local (see corresponding sections in Chapters 3 and 4).

For other species of seabirds and resting birds, it can be assumed that the designations 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 because they exclude uses that are incompatible with nature conservation. These definitions protect important habitats and reduce habitat impairment and collision risks there. Outside the nature conservation areas, the occurrence of some species is large-scale 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 sub-chapters in chapters 3 and 4). In addition, some spatial planning designations (e.g. on shipping) are not expected to lead to a densification or increased intensity of use but rather represent replications of existing levels of activity.

As a result of the SEA, significant cumulative impacts of the spatial planning designations on the protected asset seabirds and resting birds are not to be expected according to the current state of knowledge. For the designations on the extended priority area EN13 and the conditional priority area EN13-North in relation to the main concentration area, this assessment can be made only in consideration of the overall plan assessment of the ROP (cf Chapter 7).

4.11.5 Migratory birds

The uses considered in the spatial plan can have different impacts on migratory birds (e.g. barrier effects and risk of collision) in particular from the use of offshore wind energy as a result of the vertical structures of the offshore wind turbines. These effects are considered location-specifically in the environmental impact assessment and are monitored in the subsequent monitoring of the erection and operation phase of offshore wind farm projects.

By defining priority and reserved areas for offshore wind energy in a spatial context and securing open space in nature reserves, barrier effects and collision risks in important food and resting habitats are reduced. The impacts of the other uses or their designations 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 designations of all considered uses on migratory birds can be excluded with the necessary certainty.

4.12 Cross-border impacts

The SEA concludes that, as things stand at present, the designations of the ROP do not have significant impacts on the areas of neighbouring countries bordering the German EEZ of the North Sea.

Significant cross-border impacts can generally be ruled out for the following protected assets: seabed, water, plankton, benthos, biotopes, landscape, cultural heritage, and other material assets and the protected asset human beings and human health. Possible significant transboundary impacts could only arise if all of the planned wind farm projects in the area of the German North Sea are taken into account cumulatively for the highly mobile objects of protection, marine mammals, sea and resting birds, migratory birds and bats and if no avoidance and mitigation measures are ordered in the context of downstream approval procedures.

With regard to the protected asset fish, the SEA comes to the conclusion that, according to the current state of knowledge, no significant cross-border impacts on the protected asset are to be expected as a result of the implementation of the ROP because, on one hand, the areas for which the ROP makes designations do not have a prominent function for the fish fauna. On the other hand, the recognisable and predictable effects are of a small-scale and temporary nature. Based on current knowledge and taking into account avoidance and mitigation measures, significant transboundary impacts can also be ruled out for the protected marine mammal species. For example, the installation of the foundations of wind turbines and converter platforms is only permitted in the specific approval procedure if effective noise mitigation measures are implemented. For the protected asset seabirds and resting birds, the Danish bird conservation area "Sydlige Nordsø" which directly borders the German EEZ to the north and also has a high seabird population, must be taken into consideration when considering possible significant transboundary impacts. Based on current knowledge, the spatial development plan is not expected to have any significant effects as a result of the definitions.

For migratory birds, erected wind turbines in particular can represent a barrier or a risk of collision. By defining areas for wind energy exclusively outside marine protected areas, these effects are reduced in important resting areas for some migratory bird species. The other applications taken into account in the spatial development plan have no comparable spatial effects. According to the current state of knowledge, no significant transboundary impacts on migratory birds are to be expected from the designations in the spatial plan.

5 Species protection law assessment

5.1 General part

As explained above, the plan area, the German EEZ in the North Sea, contains several European wild bird species within the meaning of Article 1 of the Birds Directive and marine mammal species listed in Annexes II and IV of the Habitats Directive.

Whether the plan meets the wildlife conservation requirements of Section 44, paragraph 1, No. 1 and No. 2 BNatSchG for specially and strictly protected animal species is examined in the context of this study on assessment of wildlife conservation regulations. In particular, it is examined whether the plan violates species protection prohibitions.

In accordance with Section 44, Paragraph 1, No. 1 BNatSchG, killing or injuring wild animals of specially protected species, (i.e. animals listed in Appendix IV of the Habitats Directive and Appendix I of the V-RL Birds Directive is prohibited. The species protection assessment in accordance with Section 44, paragraph 1, No. 1 BNatSchG always refers to the killing and injury of individuals.

In accordance with Section 44, paragraph 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 context, it does not matter whether a relevant harm or disturbance is based on reasonable grounds nor do motivations, motives, or subjective tendencies play a role in the fulfilment of the prohibitions (Landmann/Rohmer Umweltrecht Band I - Kommentar zum BNatSchG, 2018, S. § 44 Rn. 6).

According to the legal definition of Section 44, Paragraph 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 guidance document on the strict protection of animal species of Community interest under the Habitats Directive (marginal number 39), disturbance within the meaning of Section 12 of the Habitats Directive occurs if the act in question reduces the chances of survival, reproductive success, or the ability to reproduce of a protected species or if this act leads to a reduction in its distribution area. On the other hand, occasional disturbances which are not likely to have a negative impact on the species concerned are not to be regarded as disturbance within the meaning of Article 12 of the Habitats Directive.

Among the uses identified in the plan, wind energy production represents 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 under species protection law.

In the following, species protection concerns are examined with regard to <u>wind energy generation</u>. Subsequently, possible cumulative impacts with other uses are presented.

5.2 Marine mammals

In the German North Sea EEZ, the harbour porpoise, common seal and grey seal are species listed in Annex II (animal and plant species of Community interest whose conservation requires the designation of special areas of conservation under the Habitats Directive) and Annex IV (animal and plant species of Community interest requiring strict protection) of the Habitats Directive, which must be protected under Article 12 of the Directive. Harbour porpoises occur in varying densities throughout the year depending on the area. This also applies to seals and grey seals. In general, it can be assumed that the entire German North Sea EEZ is part of the harbour porpoise habitat. Here, the German EEZ is used by the porpoises for passage but also for stopover and, in some cases, as feeding and nursing grounds.

The occurrence of the animals varies greatly in individual areas – both spatially and temporally. For marine mammals and, in particular, for the strictly protected species harbour porpoise, impacts resulting from the implementation of the plan have to be assessed in terms of the species protection law.

In the North Sea EEZ, three nature conservation areas were designated by ordinance in 2017 to conserve and, where necessary, restore to favourable conservation status the species listed in Annex II of Directive 92/43/EEC, namely the harbour porpoise, common seal and grey seal. The nature conservation area “Sylter Außenriff – Östliche Deutsche Bucht” has the function of a nursery area*. In the period from 1 May until the end of August, mother-calf pairs are frequently recorded in the area of the “Sylt Outer Reef - Eastern German Bight” nature reserve. The "Borkum Riffgrund" nature conservation area is of great importance for harbour porpoises in spring and partially in the early summer months. Significant densities are regularly recorded during this period. The Doggerbank nature conservation area has a lower occurrence than the other two nature conservation areas. In the Doggerbank area, animals have mainly been recorded during the summer months. Mother-calf pairs also occur here. Their presence in the summer months also suggests a function as a breeding area.

In addition, the noise abatement concept of the Federal Environment Agency (BMU) (2013) identified a main concentration area of harbour porpoise in the period from 1 May to the end of August within the German Bight 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 conservation area for harbour porpoises in the spatial plan because of its special importance for porpoise population conservation. The special importance of the reserve derives from the regular occurrence of harbour porpoises and the presence of mother-calf pairs during the summer months within this area.

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. Reservation area EN4, and priority area EN13 as well as a part of priority area EN11 (near the nature conservation area) have a medium (in summer even a high) importance for harbour porpoises because of the new findings and are part of the main concentration area of harbour porpoises in the German North Sea (BMU, 2013). The EN5 reservation areas is located in the main harbour porpoise concentration area and is used both as a feeding and nursing ground for harbour porpoises - even though the focus of the concentration is located within sub-area I of the "Sylt Outer Reef - Eastern German Bight" nature conservation area. The EN5 area is of great importance in the summer months as part of the harbour porpoise nursing area in the German Bight.

The priority areas EN6 to EN12 are of medium importance for harbour porpoises and low importance for grey seals and common seals. In general, the EN4 and EN5 priority areas and, to some extent, the EN11 and EN13 priority areas are expected to be of high importance for harbour porpoises. The priority areas EN4 and EN5 are of low to medium importance for grey seals and common seals. Priority areas EN11 and EN13 are of minor importance for grey seals and common seals. Priority areas EN14 to EN18 are of medium importance for harbour porpoises and of low importance for common seals and grey seals. The EN19 reservation area, like the Doggerbank nature conservation area, is of high importance for harbour porpoise during the summer months and marks the edge of a large concentration area east of the British Isles. The EN19 reserve is of minor importance for common seals and grey seals.

5.2.1 Section 44, paragraph 1, No. 1 BNatSchG (prohibition of killing and injury)

Under Section 44 subsection 1 number 1 of the BNatSchG, the killing or injury of wild animals of specially protected species, i.e., inter alia, animals listed in Annex IV to the Habitats Directive, is prohibited. The species protection assessment in accordance with Section 44, Paragraph 1, No. 1 BNatSchG always refers to the killing and injury of individuals (Gellermann, in: Landmann/Rohmer Umweltrecht, last revised: 91. EL September 2019, Section 44 BNatSchG, marginal number 51). The assessment is carried out for areas EN1 up to and including EN19.

The main threats with fatal outcomes for harbour porpoise in the ASCOBANS Agreement Area, which encompasses the German EEZ in the North Sea, include by-catch in gillnets and trawl nets, attacks by dolphins, depletion of food resources, physiological effects on reproductive capacity and infectious diseases, possibly as a result of contamination with pollutants. The investigations of 1692 deaths 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 by-catch in 17%. Another 15% had starved to death, and 4% were stranded alive (Evans, 2020).

Evidence of collisions with ships exists for at least 21 cetacean species (Evans, 2003, cited in Evans 2020). However, collision risks are highest for large cetacean species, such as the fin whale or the humpback whale (Evans, 2020). A study on the causes of deaths on the coasts of the British Isles has shown that about 15% to 20% of baleen whales (fin whale, minke whale) have had injuries that could have resulted from collisions with ships. In contrast, only 4% to 6% of small cetaceans, such as harbour porpoise and dolphin, 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 specified in the plan is possible as a result of the input of impulse noise during pile driving for the foundation of installations.

Marine mammals, and in particular the highly protected harbour porpoise species, would be highly likely to be injured or even killed by pile-driving for the foundations of offshore wind turbines, substations or other platforms if no prevention and mitigation measures were taken.

In its comments, BfN regularly assumes that, according to the current state of 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 µPa^2/Hz or a peak level of 200 dB re 1 µPa.

According to the estimation of the BfN, it is ensured with sufficient certainty that, if the specified limit values of 160 dB for the sound event level (SEL_{05}) and 190 dB for the peak level at a distance of 750 m from the emission point are observed, it will not be possible for the harbour porpoise to be killed or injured according to Section 44, Paragraph 1, No. 1 BNatSchG.

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 Spatial Plan on the basis of existing knowledge, in particular from the enforcement procedures at the existing installations already in operation. The plan lists objectives and principles that set a framework for downstream planning levels and individual planning approval. In the downstream procedures, specifications, orders and requirements are made considering the necessary noise abatement measures and other avoidance and mitigation measures by means of which the realisation of the prohibition can be excluded or the intensity of any adverse effects can be reduced. The measures are strictly monitored in order to ensure with necessary certainty that the killing and injury provisions according to Section 44, Paragraph 1, No. 1 BNatSchG do not come into effect.

The update of the plan contains principles according to which the input of sound into the marine environment during the construction of installations is to be avoided according to 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 specification with regard to individual work steps such as deterrence measures as well as a slow increase in pile driving energy by means of “soft-start” procedures within the framework of the subordinate procedures, the site development plan, the suitability assessment of sites and, in particular, within the framework of the respective planning approval as well as within the framework of enforcement. By means of deterrence measures and the “soft-start”, it can be ensured 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.

According to the precautionary principle, the aforementioned avoidance and mitigation measures can exclude the realisation of the prohibition on killing. The use of appropriate deterrent measures will ensure that the animals are outside the 750-metre radius of the point of emission. In addition, because of the required degree of noise mitigation specified in the draft determination of suitability, it can be assumed that no lethal or long-term adverse sound impacts will occur outside the area in which harbour porpoises are not expected to be present because of the deterrence measures to be carried out.

According to the above, the findings show with sufficient certainty that the prohibited factual circumstances according to the species protection law of Section 44, Paragraph 1, No. 1 BNatSchG are not fulfilled.

According to the current state of knowledge, neither the operation of the installations nor the laying and operation of the wind farm's internal submarine cabling will have any significant negative impacts on marine mammals that meet the killing and injury criteria under Article 44 subsection (1) number 1 of the Federal Nature Conservation Act.

Since 2018, the Fauna Guard System has been installed as a deterrent measure in all construction projects in the German North Sea EEZ. 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 impacts of the Fauna Guard system are currently being systematically analysed and – if necessary – the application of the system optimised for future construction projects (FaunaGuard study, 2020, in preparation).

To avoid cumulative effects, prohibitions will be imposed in the context of downstream approval procedures and enforcement to ensure that no animals are injured or killed by multiple sources of impulse sound inputs acting at the same time. For example, no pile driving is permitted during the blasting of non-transportable ammunition.

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, violation of the species protection prohibitions of Section 44 subsection 1 number 1 of the BNatSchG.

Furthermore, according to the current state of knowledge, neither the operation of the installations 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 according to Section 44, Paragraph 1, No. 1 BNatSchG.

5.2.2 Section 44, paragraph 1, No. 2 BNatSchG (prohibition of disturbance)

Under Article 44 subsection (1) number 2 of the Federal Nature Conservation Act, it is also prohibited to cause significant disturbance to wild animals of strictly protected species during the reproduction, rearing, moulting, wintering and migration periods.

The harbour porpoise is a strictly protected species in accordance with Appendix IV of the Habitats Directive and thus within the meaning of Section 44, Paragraph 1, No. 2 in conjunction with Section 7, Paragraph 1, No. 14 BNatSchG so that a species protection assessment must also be carried out in this regard.

The species protection assessment under Section 44 subsection 1 number 2 of the BNatSchG (BNatSchG) relates to population-relevant disturbances of the local population, the occurrence of which varies in the German North Sea EEZ.

In its comments in the context of approval and enforcement procedures, the BfN regularly examines the existence of a species-specific disturbance within the meaning of Section 44, Paragraph 1, No. 2 BNatSchG. The concluding result is that the occurrence of a significant disturbance as a result of construction-related underwater noise can be avoided in regard to the protected asset harbour porpoise as long as the sound event level of 160 dB or the peak level of 190 dB is not exceeded at a distance of 750 m from the emission point and sufficient evasion areas are available in the German North Sea. BfN demands that the latter be ensured by coordinating the timing of noise-intensive activities of different project developers with the aim of ensuring that no more than 10 % of the area of the German North Sea EEZ is affected by noise (BMU 2013).

<u>Construction-related effects of wind energy generation</u>

The temporary implementation of the pile driving work is not expected to cause significant disturbance to harbour porpoises within the meaning of Section 44, paragraph 1, No. 2 BNatSchG.

According to the current state of knowledge, it is not to be assumed that disturbances that may occur because of 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 are in 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 mitigated. However, this must be investigated 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 mitigation systems in the sense of the principles and objectives in the update of the plan as well as subsequent orders in the planning approval of the BSH and consideration for 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 specifying orders that ensure effective noise abatement management through appropriate measures.

Following the precautionary principle, measures to prevent and mitigate the impacts of noise during construction are defined according to 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 mitigating and environmental protection measures are regularly ordered as part of the planning approval procedure:

- Preparation of a sound prognosis taking into consideration the location- and installation-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 specified soundproofing concept adapted to the selected foundation structures and erection processes for the implementation 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 noise mitigation 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 noise abatement 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 noise mitigating measures,
- operating noise-mitigating insallation design according to the state of the art.

As outlined above, deterrence measures and a soft-start procedure must be applied in order 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 prevent the risk of killing according to Section 44, Paragraph 1, No. 1 BNatSchG 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, judgement of 27 November 2018 - 9 A 8/17, cited in juris).

For deterrence up until 2017, a combination of pingers was used as a pre-warning system, followed by the use of the so-called Seal Scarers as a warning system. All the results of the monitoring by means of 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, scaring by means of seal scarers is accompanied by a large habitat loss caused by the flight reactions of animals and therefore constitutes a disturbance (Brandt et al., 2013, Dähne et al., 2017, Diederichs et al., 2019).

To prevent this, a new system for deterring animals from the danger zone of the construction sites, the so-called Fauna Guard System, has been used in construction projects in the German North Sea EEZ 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 Section 44, Paragraph 1, No. 1 BNatSchG can be excluded with certainty without leading to a simultaneous realisation of the disturbance elements within the meaning of Section 44, Paragraph 1, No. 2 BNatSchG.

The use of the Fauna Guard system is accompanied by monitoring measures. As part of a research project, the impacts of the Fauna Guard System are being systematically analysed. 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 mitigating measures by the subsequent sponsors 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. Findings based on practical experience in the application of technical noise-reducing systems and from experience with the control of the pile driving process in connection with the characteristics of the impact piling 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", "EnBWHoheSee" and others. A recent study commissioned by the BMU (BELLMANN, 2020) provides a cross-project evaluation and presentation of the results from all technical noise mitigation measures used in German projects to date.

The results of the very extensive monitoring of the construction phase of 20 offshore wind farms have confirmed that the measures to avoid and reduce disturbances to harbour porpoise arising from impact noise are effectively implemented and that the requirements of BMU's noise abatement concept (2013) are reliably met. The current state of knowledge takes into account construction sites at water depths ranging from 22 m to 41 m, in seabed soils ranging from homogeneous sandy to heterogeneous and difficult to penetrate profiles, and piles with diameters of up to 8.1 m. It has been shown that the industry has found solutions in the various procedures to effectively harmonise installation processes and noise protection.

According to the current state of knowledge and based on the development of technical noise abatement 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 m.

In addition, the plan approval decision of the BSH will specify monitoring measures and noise measurements in detail in order to detect a possible hazard potential on site on the basis of the actual project parameters and, if necessary, to initiate optimisation measures.

New findings confirm that the reduction of noise input through the use of technical noise mitigation systems clearly reduces disturbance effects on harbour porpoises. The minimisation of effects concerns both the spatial and temporal extent of disturbances (DÄHNE et al., 2017, BRANDT et al. 2016, DIEDERICHS et al., 2019).

In order to avoid cumulative impacts caused by parallel pile driving work on different projects, a temporal coordination of pile driving work is ordered within the framework of subordinate planning approval procedures and enforcement in accordance with the specifications of the noise abatement concept of the BMU (2013). The noise abatement concept of the BMU (2013) pursues a site-based approach with the objective of always maintaining sufficient high-quality alternative habitats for the harbour porpoise population in the German EEZ of the North Sea free of disturbance-triggering noise inputs.

In actual terms, the coordination of pile driving activities, including deterrent measures, across projects will ensure that the noise protection values are complied with at 750 m and that at no time will more than 10% of the area of the German EEZ in the North Sea be affected by disturbance-inducing impulse sound. It is assumed that disturbances can occur at an unweighted broadband SEL of 140 dB re 1µPa2S, which would be expected if the noise protection values mentioned above were observed within a radius of about 8 km around the respective pile-driving point.

Cumulative effects on marine mammals, in particular harbour porpoises, may occur mainly due to noise exposure during the installation of foundations using impact pile driving. For example, marine mammals can be significantly adversely affected if pile driving is carried out simultaneously at different sites within the EEZ without equivalent alternative habitats being available.

The realisation of offshore wind farms and platforms to date has been relatively slow and gradual. In the period from 2009 to 2018 inclusive, pile driving work was carried out on twenty wind farms and eight converter platforms in the German North Sea EEZ. Since 2011, all pile driving work 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 mitigation systems (Bellmann, 2020 in preparation).

The majority of the construction sites were located at distances of 40 km to 50 km away from each other, so that there was no overlap of noise-intensive pile driving 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 N-4 was it necessary to coordinate the pile driving, including deterrent measures.

The evaluation of the noise results with regard to noise propagation and the possibly resulting accumulation has shown that the propagation of impulsive noise is strongly limited when effective noise-minimising measures are applied (DÄHNE et al., 2017).

Current findings on the 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 Federal Association of Wind Farm Operators Offshore (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 survey 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.

The 2019 study, which is concerned with the evaluation of the data from the period 2014 to 2018 inclusive, comes to the conclusion that the optimised use of the technical sound reduction measures since 2014 and the resulting reliable compliance with the limit value has not led to any further reduction of the displacement effects on harbour porpoises compared to the phase from 2011 to 2013 with sound reduction systems that had not yet been optimised. The displacement radius determined in both studies is approximately 7.5 km, thus confirming the assumptions made in BMU's noise abatement concept (2013). However, the most recent study also showed that no reduction in displacement effects was detected above a sound level of 165 dB (SEL_{05} 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, taking into consideration psychoacoustic reactions of the animals, differences in food availability, and effects of deterrence by means of seal scarers as well as the activity of the respective construction site and 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 noise mitigation measures. It has been shown that the displacement and thus also the disturbance in construction sites with the use of noise mitigation systems is significantly lower than in construction sites without noise mitigation systems (Diederichs et al. 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 aforementioned strict noise protection and noise mitigation measures are applied in accordance with the principles and objectives of the plan and the orders in the planning approval decisions, taking into consideration the noise abatement concept of the BMU (2013) and compliance with the limit value of 160 dB SEL_5 at a distance of 750 m, significant disturbances within the meaning of Section 44, Paragraph 1, No. 2 BNatSchG are not to be feared. Furthermore, the BfN's demand to coordinate the timing of noise-intensive construction phases of different project developers in the German North Sea EEZ in accordance with the BMU's Noise Abatement Concept (2013) is mandated.

<u>Operational effects of wind energy production</u>

According to the current state of knowledge, the <u>operation</u> of offshore wind turbines cannot be assumed to cause disturbance in accordance with Sectoin 44, paragraph 1, No. 2 BNatSchG. According to the current state of knowledge, no negative long-term effects on harbour porpoises as a result of noise emissions from the turbines are to be expected if the installations are constructed in a regular manner. Any impacts are limited to the immediate vicinity of the installation and depend on the noise propagation in the specific area and, not least, on the presence of other noise sources and background noise such as shipping traffic (MADSEN et al. 2006). This is confirmed by findings from experimental work on the perception of low-frequency acoustic signals by harbour porpoises using simulated operating noise from offshore wind turbines (LUCKE et al. 2007b): Masking effects were recorded at simulated operating noises of 128 dB re 1 µPa at frequencies of 0.7, 1.0 and 2.0 kHz. In contrast, no significant masking effects were found at operating noise levels of 115 dB re 1 µPa. The first results thus indicate that masking effects due to operating noises can only be expected in the immediate vicinity of the given installation, with the intensity again depending on the type of installation.

Standardised measurements during the operating phase of offshore wind farms in the German North Sea EEZ have confirmed that, from an acoustic point of view, the underwater noise outside the wind farm areas cannot be clearly distinguished from the background noise that is permanently present. Only low-frequency sounds can be measured at a distance of 100 m from the respective wind turbine. However, with increasing distance from the installation, the noise from the installation is only insignificantly different from the ambient sound. At a distance of only 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 noise emitted by the installations cannot be clearly identified from other sound sources (e.g. waves or ship noise) even at short distances. The wind farm-related shipping traffic was also hardly differentiated from the general ambient noise, which is introduced by various sound sources such as other shipping 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 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 surveys, the use of the area of the wind farm or of two reference areas by harbour porpoises was considered before the construction of the installations (baseline survey) 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 with 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 correlation 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 due to a "reef effect" or calming of the area due to the absence of fishing and shipping or possibly a positive combination of these factors.

The results of the investigations during the operational phase of the "alpha ventus" project also indicate a return to distribution patterns and abundances of harbour porpoise that are comparable - and in some cases higher - than those from the baseline survey of 2008.

The results from the monitoring of the operational phase of offshore wind farms in the EEZ have so far not yielded clear results. The investigations in accordance with StUK4 using aircraft-based survey has so far revealed fewer sightings of harbour porpoises inside the wind farm areas than outside. However, the acoustic survey of habitat use by means of special underwater measuring devices known as 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 survey from the aircraft and acoustic survey 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 according to Section 44, Paragraph 1, No. 2 BNatSchG does not come into effect, an operational noise mitigating system design according to the state of the art will be used in line with the corresponding requirement of the subordinate determination of suitability as well as 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 survey and assess any location 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 Section 44, Paragraph 1, No. 2 BNatSchG.

<u>Cumulative view</u>

In Chapter 4.11.3, cumulative effects of offshore wind energy production on harbour porpoises were presented and avoidance and mitigation measures were described. However, the harbour porpoise is exposed to the impacts of various anthropogenic uses as well as natural and climate-induced changes. A differentiation or even weighting of the proportion of impacts by a single 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 within the framework of individual approval procedures.

The evaluation of current data on the occurrence of the harbour porpoise in the German North Sea EEZ has shown changes in the occurrence and population trends in the years 2012 to 2018. Results of the large-scale survey of the North Sea population have also demonstrated a shift in the population in the southern North Sea. The authors of the study assume a variety of causes for the observed changes, including previous impacts from fisheries, pollutants, decline in the health status, noise inputs from offshore activities and shipping, changes in food supply due to the displacement of fish stocks and, of course, cumulative effects (Gilles et al, 2019).

Spatial planning and the designations of the plan, including the principles and objectives, are among the central instruments for mitigating or even preventing cumulative impacts on the harbour porpoise population through the equalisation of spatial conflicts between uses and the designation of priority and reservation 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 within the framework of individual approval procedures.

In addition, the 2013 noise prevention concept for the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety for the North Sea includes a number of requirements, through the habitat approach pursued, which ensure effective prevention and reduction of cumulative effects on the local harbour porpoise population in the German EEZ and the populations in the nature conservation areas due to impact noise. This plan has designated the main concentration area of harbour porpoises in the German North Sea EEZ that was identified, during the preparation of the noise prevention concept for the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2013), as the protected area for harbour porpoises during the sensitive period from 1 May to 31 August. The special requirements of the noise prevention concept for the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety are arranged in the nature conservation areas and the protected area as part of the subordinate procedures or individual approval procedures for applications.

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 Section 44, paragraph 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 statutory instrument according to Section 54, Paragraph 1 are considered to be specially protected in accordance with Section 7, Paragraph 1, No. 13 c BNatSchG. The ordinance BArtSchV, issued on the basis of Section 54, Paragraph 1, No. 1 BNatSchG, lists native mammals as specially protected; these thus also fall under the species protection provisions of Section 44, Paragraph 1, No. 1 BNatSchG. As a matter of principle, the considerations listed in detail for harbour porpoises regarding noise pollution from the construction and operation of offshore wind turbines apply to all other marine mammals 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: On the one hand, the sensory systems are morphoanatomically and functionally species-specific. As a result, marine mammal species hear and react to sound differently. Moreover, both perception and reaction behaviour depend on the respective habitat (KETTEN 2004).

The areas in the plan are of low to medium importance for harbour seals and grey seals. The closest frequently frequented breeding and resting sites are located at a great distance on Helgoland and on the East Frisian and North Frisian islands.

Harbour seals are generally considered tolerant of sound activities, especially in case of an abundant food supply. However, escape reactions during seismic activity have been detected by telemetric investigations (RICHARDSON 2004). According to all current findings, seals can still hear pile-driving sounds at a distance of more than 100 km. Operating noise from 1.5 to 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).

All in all, it can be assumed that the species protection requirements can be met due to the long distances to casting grounds and moorings and the protective measures provided.

With regard to the harbour seal and grey seal, the avoidance and mitigation measures already listed for the harbour porpoise apply.

As a result, it can be concluded with regard to seals and grey seals that the implementation of the plan does not contravene the prohibitions under section 44 subsection 1 number 1 and 2 of the BNatSchG (BNatSchG) with regard to other marine mammals either.

5.3 Avifauna

In the areas identified in the ROP, protected bird species of Appendix I of the V-RL occur in varying densities. Against this background, the compatibility of the plan with Section 44, Paragraph 1, No. (1) BNatSchG (prohibition of killing and injury) and Section 44, Paragraph 1, No. 2 BNatSchG (disturbance of strictly protected species and European bird species) must be examined and ensured.

All findings to date indicate a medium importance of areas EN1, EN2 and EN3 for seabirds, including species listed in Annex I of the Birds Directive. Although the area EN4 is only of medium importance for most seabird species, divers occur there in high densities in spring. Due to its location within the main concentration area of divers, the EN4 area is of high importance. The EN5 area is also located in the identified main concentration area of divers in spring in the German Bight and is therefore of great importance for the specially protected divers. The EN5 area and its surroundings have a high occurrence of seabird species, in particular protected species of Annex I of the Birds Directive, such as the easily disturbed divers. The area of areas EN6 to EN13 is outside the concentration concentrations of various bird species listed in Annex I of the Birds Directive, such as divers, terns, little gulls and petrels. Areas EN14 to EN19 show a typical community of seabirds, including fulmar, kittiwake, razorbill and guillemot.

In addition, parts of the EEZ have an average to above-average importance for bird migration. Significant populations of songbirds breeding in northern Europe are thought to migrate across the North Sea. However, guidelines and concentration areas for bird migration are not present in the EEZ. There are indications that migration intensity decreases with distance from the coast. However, this has not been clarified for the mass of songbirds migrating at night.

Among the uses defined in the ROP, wind energy generation is the most intensive use – also with regard to possible impacts on seabirds. At the same time, wind energy generation is the only use that is controlled by the BSH within the framework of subordinate procedures. In recent years, the monitoring of the operating phase of offshore wind farms in the German EEZ has increased the level of knowledge in connection with impacts relevant to species protection law**.**

5.3.1 Section 44, paragraph 1, No. 1 BNatSchG (prohibition of killing and injury)

The species protection assessment in accordance with Section 44 subsection 1 number 1 BNatSchG relates to the killing and injury of individual animals and is therefore carried out uniformly for all areas of the plan EN1 up to and including EN19.

In accordance with Section 44, paragraph 1, No. 1 BNatSchG in conjunction with Article 5 V-RL*, it is prohibited to hunt, capture, injure, or kill wild animals of specially protected species. Specially protected species include the species listed in Annex I of the Birds Directive, species whose habitats and habitats are protected in nature conservation areas and in the area reserved for divers, as well as characteristic species of the areas to which the plan relates. Accordingly, injuring or killing resting birds as a result of collisions with wind turbines must be ruled out in principle. 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, a collision of divers is not to be expected because of their pronounced avoidance behaviour towards vertical obstacles.

In the planning and approval of public infrastructure and private construction projects, it is to be assumed that unavoidable operationally-related deaths or injuries of individual animals (e.g. through collision of bats or birds with wind turbines) as the actualisation of socially adequate risks do come within the scope of the prohibition (BT-Drs. 16/5100, p. 11 and 16/12274, p. 70 f.). Attribution occurs only if the risk of success is significantly increased by the project because of 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 risk reduction are to be included in the assessment; cf LÜTKES/EWER/HEUGEL, SECTION 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, Section 44 BNATSCHG, MARGINAL NO. 14, 2011.

In its statements on offshore wind farm projects, BfN regularly states that due to changes in the technical size parameters of the wind turbines in current projects compared to the implementations from 2011 to 2014, the result is generally an increase in vertical obstacles in the airspace. However, based on current knowledge, an increased risk of bird strike cannot be quantified due to the simultaneous reduction in the number of turbines. It is true that individual collision-related losses caused by the erection of a fixed installation in previously obstacle-free areas cannot be completely ruled out. However, the measures ordered (e.g. 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 operating phase so as to facilitate an improved nature conservation assessment of the actual risk of bird strikes at the turbines. Moreover, the right to arrange further measures is expressly reserved on regular occasions. Against this background, the BSH does not believe that there is a significant increase in the risk of killing or injuring migratory birds. Consequently, the plan does not violate the prohibition on killing and injury pursuant to Section 44 subsection 1 number 1 of the

BNatSchG. The BfN regularly comes to the same conclusion in its statements on wind farm projects.

According to the current state of knowledge, a site-related significantly increased risk of collision of individual stopover bird species in areas EN1 to EN19 of the plan is not apparent.

It can therefore not be assumed that the prohibition on injury and killing of Section 44, paragraph 1, No. 1 BNatSchG is realised.

5.3.2 Section 44, paragraph 1, No. 2 BNatSchG (prohibition of disturbance)

As described above, the plan area is home to several species of European wild birds as defined in Article 1 of the Birds Directive, including the red-throated diver, black-throated diver, little gull, sandwich tern, common tern, arctic tern, petrel, fulmar, gannet and guillemot. Against this background, the compatibility of the plan with Section 44 subsection 1 number 2 BNatSchG in conjunction with Article 5 of the Birds Directive must be ensured.

In accordance with Section 44, paragraph 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 significant disturbance exists if the disturbance worsens the conservation status of the local population of a species.

The species protection assessment under Section 44 subsection 1 number 2 BNatSchG refers to the population-relevant disturbances of local stocks, the occurrence of which varies in the areas covered by the plan. The results of the species protection assessment are therefore subsequently presented for individual areas or groups of areas with comparable occurrences.

The species protection assessment is based on the following considerations with regard to seabird species listed in Annex I of the Birds Directive, species with another protected status and those with relatively high abundance in the EEZ:

<u>Divers *(Gavia stellata* and *Gavia arctica*)</u>

Red-throated diver (*Gavia stellata*) and black-throated diver (*Gavia arctica*) are common migratory seabird species in the Northern Hemisphere with breeding grounds 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). For the black-throated diver, between 53,800 - 87,800 breeding pairs are assumed in Europe. The global stock 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 migratory birds during the species-specific migration periods and in winter.

The local population of divers should be taken into account when assessing the significant disturbance to stopover divers. This is a subset of the NW European winter stopover population, the so-called offshore population of divers. The NW European biogeographical population, which includes the red-throated divers resting in Germany, has shown strong declines in the years 1970-1990, especially in the Russian and Fennoscandian populations. Despite stable and sometimes increasing population trends, as in the UK, the population has not yet returned to its original numbers. The reasons for this negative trend are of an anthropogenic nature and include environmental pollution, such as oil spills. The oil spill from the tanker “Erika” off the French coast resulted in the deaths of 248 red-throated divers, among others (CADIOU & DEHORTER 2003). Gillnet fishing (WARDEN 2010) and the discharge of nutrients into the sea also contribute to the decline of the stocks. The black-throated diver stock has suffered equally from these and other interventions in its natural habitat and has also shown stock 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 point downwards (BirdLife International 2015).

Due to the fact that their populations have still not fully recovered or are still declining, both species of diver are included in endangered categories of some European conservation lists, such as "SPEC 3" ("Widespread species not concentrated in Europe but showing negative trends and an unfavourable conservation status there"). Red-throated divers and black-throated divers also belong to the species listed in Annex I of the EU's Birds Directive and are also listed in the Ordinance establishing the nature conservation area "Sylt Outer Reef - Eastern German Bight".

Aside from the worrying developments in the European population, red-throated and black-throated divers are also among the species most vulnerable to disturbance.

Red-throated and black-throated divers are among the bird species most sensitive to shipping traffic in the German North Sea. Visual disturbance caused by shipping traffic can cause deterrent or avoidance reactions. Ship-based bird counts have already shown that divers are disturbed by the approaching ship at a great distance and soar 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 of the birds is to fly away. Escape distances vary and can be associated with different individual and ecological factors (Fließbach et al. 2019).

Direct impacts on divers as a result of visual disturbance are to be expected in particular along busy traffic routes or traffic separation areas as well as in the vicinity of wind farms because of 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 to the stock of divers in spring in their main concentration area measures for adapting shipping logistics are being examined. Depending on the location of the wind farm in the main area of concentration of divers, such measures may include shifting certain regular maintenance activities outside spring, reducing navigation speeds or adjusting the route.

As a result, the SEA assessments for SDP 2019 and SDP 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 impacts as a result of the avoidance behaviour are intense and permanent.

In order to prevent a deterioration of the conservation status of the local population because of 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 SDP 2019 and SDP 2020 in Chapter 5 North Sea Environmental Report.

The BSH concludes that significant disturbance within the meaning of Section 44, Paragraph 1, No. 2 BNatSchG as a result of implementation of the plan can be ruled out 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, according to the current state of knowledge, that the disturbance requirement according to Section 44, paragraph 1, No. 2

BNatSchG is fulfilled. For the designations for the extended priority area EN13 and the conditional priority area EN13-North, this assessment can be made only in consideration of 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 scaring effects in 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 1 January 2030. Therefore, the extent to which avoidance and mitigation measures must be applied to the specific installations applied for must be examined in the individual procedure.

<u>Little Gull (*Larus minutus*)</u>

The population of the little gull in Europe is divided into two biogeographic populations. The population, which breeds from Scandinavia to Russia and partly occurs in the North Sea and Baltic Sea in winter, 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 little gull is found mainly in the waters and coastal areas of Lower Saxony and Schleswig-Holstein during the main migration periods (MENDEL et al. 2008).

With regard to possible impairments of the little gull by the wind turbines, the risk of collision can be classified as low. Studies showed that the flight altitude is mostly below the rotor height (< 30 m) (MENDEL et al. 2015).

GARTHE & HÜPPOP (2004) classified the little gull as quite insensitive to offshore wind turbines with a WSI (Wind Farm Sensitivity Index) value of 12.8. Investigations into the potential avoidance behaviour of the little gull do not yet provide a uniform picture.

Due to the relatively low observed densities of the little gull in the areas EN1 to EN13 inclusive, as well as their temporary coupling to the species-specific main migration periods, it can be assumed that the areas are of low to at most medium importance for the little gull. Determinations of the stopover population were based on observed maximum densities which are subject to interannual fluctuations. Cumulative effects on the population are not to be expected according to current knowledge.

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 according to Section 44, paragraph 1, No. 2 BNatSchG is fulfilled.

<u>Terns</u>

The sandwich tern (*Sterna sandvicensis*), which breeds in Germany, belongs 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 into the Baltic Sea. The population size is estimated at 160,000–186,000 individuals (WETLANDS INTERNATIONAL 2012). About 9,700 - 10,500 breeding pairs belong to the German breeding population. During the breeding season, sandwich terns move away from their breeding colony within a radius of 30 to 40 km. Hardly any terns seek food in waters more than 20 m deep. The year-round resting population in the German EEZ is estimated at 110–430 individuals; in sub-area II of the nature conservation area “Sylt Outer Reef - Eastern German Bight”, it is even less (MENDEL et. al. 2008).

In general, the stock is attested a stable status. In the European Red List, the species is considered “least concern” (BIRD LIFE INTERNATIONAL 2015).

Arctic terns and common terns (*Sterna paradisea, Sterna hirundo*) occur only sporadically in areas EN1 to EN13. Higher, albeit still low, densities were found only 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. However, they are not driven away completely but rather shift their inhabitation to the outside areas (PETERSEN et. al. 2006).

On the basis of the present statements, the BSH does not assume, according to the current state of knowledge, that the tern population will be disturbed by offshore wind farms. 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 according to Section 44, paragraph 1, No. 2 BNatSchG is fulfilled.

Auks

Common Guillemot (*Uria aalge*)

The common guillemot is one of the most common species of seabird in the northern hemisphere and has a breeding population of about 2.35 - 3.00 million birds in Europe. The main breeding areas of auks 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 to forage during the post-breeding season (TASKER et al. 1987).

The only breeding colony of the common guillemot in the German North Sea is on Helgoland. The breeding stock was estimated at about 2600 pairs in 2012 (GRAVE 2013). In summer, the animals tend to stay in the immediate vicinity of the breeding colony, and only occur in low densities within a radius of 30 km. In autumn and winter, guillemots increasingly spread to offshore areas with water depths between 40–50 m (MENDEL et al. 2008).

With a WSI of 12.0, the northern guillemot belongs to the lower third of the species examined for sensitivity to disturbance by GARTHE & HÜPPOP (2004). By contrast, the long-term investigations since the commissioning of the "alpha ventus" project have shown a clear avoidance behaviour on the part of the auks (also observed for the razorbill). Based on the ship surveys, a reduction in the probability of sighting of up to 75% was found within the wind farm (BIOCONSULT SH & IFAÖ 2014). The results of the StUKplus project "TESTBIRD" support these observations. During surveying flights in the first winter half years of operational monitoring (2009/2010 and 2010/2011), no auks were sighted within the wind farm or within a radius of 1-2 km. From 2012 onwards, auks were observed for the first time in the outer area of the wind farms (MENDEL et al. 2015).

Based on the current state of knowledge, no significant impact on the common guillemot population caused by offshore wind farms is expected due to the large total population and the wide geographical distribution. 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 according to Section 44, paragraph 1, No. 2 BNatSchG is fulfilled.

Razorbill (*Alca torda*)

In addition to the guillemot, the razorbill is another frequently observed auk in the North Sea. The European population is estimated at about 1 million individuals. The largest proportion (about 60%= breed on rocky coasts in Iceland followed by other important breeding areas in the British Isles and Norway (BIRDLIFE INTERNATIONAL 2015). The only breeding colony in Germany with only about 15–20 breeding pairs is on Helgoland (GRAVE 2013). During the breeding season, razorbills limit their search for food to the immediate vicinity of the breeding site. The winter resting population in the German North Sea is estimated at 7500 individuals. In the process, the animals increasingly stay within the 20 m depth range (MENDEL et al. 2008).

Because of the geographically restricted distribution of breeding areas, the razorbill is listed in the Red List of Breeding Birds ((SÜDBECK et al. 2008) under category "R" (species with geographical restriction). However, the breeding colony on Heligoland is very small and will probably not be decisive for the occurrence of razorbills in the German North Sea.

The BSH currently has no information that would indicate that a disturbance pursuant to Section 44 subsection 1 number 2 of the BNatSchG has occurred. 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 according to Section 44, paragraph 1, No. 2 BNatSchG is fulfilled.

Northern fulmar (*Fulmarus glacialis*)

The fulmar is a typical seabird and is present in the German EEZ all year round. Its main distribution area is offshore beyond the 30 m 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 Red List of the EU27. (BIRDLIFE INTERNATIONAL 2015).

Little is known so far about the fulmar's reactions to offshore wind farms under construction or in operation, as generally low sighting rates and insufficient data do not allow reliable conclusions to be drawn. However, a WSI of only 5.8 indicates a very low sensitivity to disturbance (GARTHE & HÜPPOP 2004).

Based on current knowledge, no significant impacts on the population of the northern fulmar caused by offshore wind farms are 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 according to Section 44, paragraph 1, No. 2 BNatSchG is fulfilled.

Northern gannet *(Sula bassana)*

The breeding stock of the northern gannet in Europe is estimated at around 683,000 breeding pairs (BIRDLIFE INTERNATIONAL 2015). In the German Bight, Helgoland is the only breeding site of the northern gannet. Other European breeding grounds are located, for example, along the Norwegian coast and on the famous Scottish island of Bass Rock. As a highly mobile species, the Northern gannet uses extensive foraging habitats within a radius of up to 120 km from the breeding colony (MENDEL et al. 2008). Although the Northern gannet shows an area-wide (isolated) occurrence, it is listed in the Red List in the category "R" (species with geographical concentration) because of the strong concentration of breeding areas (SÜDBECK et al. 2008). However, its stock is considered "least concern" (LC) according to European endangerment categories. (BIRDLIFE INTERNATIONAL 2015).

There are only a few studies available for the northern gannet and they are statistically insignificant, they nevertheless suggest a potential avoidance behaviour towards wind turbines. Unambiguous statements frequently cannot be made due to the high mobility of the species and, similar to the northern fulmar, the associated low sighting rates and small samples.

With regard to the low, interannually fluctuating occurrence of the northern gannet, it can be assumed that the areas are of low to medium importance as resting and feeding areas.

Based on current knowledge, no significant impact on the population of the gannet caused by offshore wind farms is 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 according to Section 44, paragraph 1, No. 2 BNatSchG is fulfilled.

Seagulls

Gulls are common in the North Sea and can be observed near the coast or offshore, depending on the species. Recorded densities of the individual species can therefore vary considerably. In addition to the little gull, which has already been dealt with separately, the most common species include lesser black-backed gull, common gull, herring gull, greater black-backed gull and kittiwake.

In general, offshore wind turbines seem to attract seagulls or not to influence their local distribution. They are also known as prominent ship followers. Among the 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 protection status) (BirdLife International 2004a). The stock of the biogeographical population, which occurs mainly in Germany, is estimated to comprise 1,200,000–2,000,000 individuals and is showing a stable population trend (Wetlands International 2012). In the Pan-European Red List and the EU27 list it is classified as “least concern” (BirdLife International 2015).

Based on current knowledge, no significant impacts on the population of the common gull caused by offshore wind farms are 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 according to Section 44, paragraph 1, No. 2 BNatSchG is fulfilled.

Reservation areas for wind energy EN14 to EN19

From Areas EN14 to EN19 in the “Duck’s Bill”, the seabird monitoring investigations conducted by the FTZ on behalf of the BfN provide information on the seabird community. This area is one of the typical habitats of seabird species. Northern fulmars and kittiwakes occur all year round, but especially in spring and winter. Razorbills and common guillemots are most abundant in winter, the latter also occurring in spring in this remote area of the EEZ. The Doggerbank area within the German EEZ belongs to the foothills of the range of the common 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. Based on current knowledge, it can be assumed that for the species occurring in the areas, the prohibition under Section 44 subsection 1 number 2 BNatSchG is not violated. A detailed species protection assessment for the reserved areas EN14 to EN19 will be carried out at subordinate levels if more detailed information and findings become available.

Lines

Deterrent effects acting on seabirds and stopover birds, as well as migratory birds are limited to the small-scale and very short periods required for laying submarine cables and pipelines. These disturbances do not go beyond those generally associated with slow shipping traffic. Therefore, no disturbance relevant to species protection law under Section 44 subsection 1 number 2 BNatSchG is to be expected from the specifications for cables and pipelines.

Cumulative impacts

In Chapter 4.11.4, cumulative effects of offshore wind energy generation on seabirds, in particular on divers, which are sensitive to disturbance, were presented. At the same time, the criteria for the qualitative assessment of the effects were described. Seabirds are also exposed to the impacts of various anthropogenic uses and natural and climate-related changes. A differentiation or even weighting of the share of the impacts 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 the qualitative assessment of cumulative effects on divers within the framework of approval procedures of offshore windparks using the main concentration area in accordance with the BMU position paper (2009). The cumulative consideration of the avoidance behaviour of divers towards offshore wind farms within the framework of studies commissioned by the BSH and the BfN revealed 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). The statistically significant decrease in abundance is not due to total avoidance but rather to partial avoidance with increasing densities of divers up to a distance of 10 km from a wind farm.

The priority areas for nature conservation contribute to the protection of open spaces because they exclude uses that are incompatible with nature conservation. 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 site development plan and the site investigation and examination of the suitability of sites 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 within the framework of individual approval procedures.

The policy paper of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2009) on the protection of divers provides the basis for assessment of the cumulative effects of wind energy generation. The designation of the identified main concentration area as a reserved area for the protection of divers represents the most important avoidance and mitigation measure so as to rule out cumulative effects at population level. Because of 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 a protected area 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 interfere as little as possible with the conservation purpose of the diver priority area. From 1 March to 15 May of a given year, it applies that there should be no adverse effects from sand and gravel extraction in the priority area for divers and that the Federal Armed Forces authorities and the competent nature conservation authority should reach agreement on military use (cf ROP Principle (3) Chapter 2.4 Nature conservation). This gives additional consideration to the protection of the diver species group, which is sensitive to disturbance and its particularly important habitat in the EEZ of the North Sea. The designation of the reservation areas for divers (StN1 to StN3) simultaneously takes account of the sustainable use of reservation 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 installations applied for.

Finally, for offshore wind farms in Areas EN1 to EN12, as well as EN14 to EN19, it is not assumed, according to the current state of knowledge, that the disturbance requirement according to Section 44, paragraph 1, No. 2 BNatSchG is fulfilled. For the designations for the extended priority area EN13 and the conditional priority area EN13-North, this assessment can be made only in consideration of 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 knowledge merely confirms that bats, especially long-distance migratory species, fly over the North Sea.

5.4.1 Section 44, paragraph 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. Under Article 12 subsection 1 number 1 a) of the Habitats Directive, all deliberate forms of capture or killing of bat species taken from the wild are prohibited. Collision with offshore structures does not constitute deliberate killing. Here, explicit reference can be made to the guideline on the strict protection of animal species of Community interest under the Habitats Directive, which assumes in II.3.6 marginal number 83 that the killing of bats is an unintentional killing that must be continuously monitored in accordance with Section 12, Paragraph 4 of the Habitats Directive. There are no indications for the examination of further facts according to Section 12, Paragraph 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 data available for the EEZ of the North Sea are fragmentary and insufficient to be able to draw conclusions about bat migration. It is not possible to draw concrete conclusions on migratory species, migration directions, migration heights, migration corridors and possible concentration ranges on the basis of the available data. Existing findings merely 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 according to Section 44, paragraph 1, No. 1 BNatSchG nor the species protection prohibition of significant disturbance in accordance with Section 44, paragraph 1, No. 2 BNatSchG are to be expected.

6 Impact assessment/Area protection assessment

6.1 Legal basis

Insofar as an area of Community importance or a European bird conservation area may be significantly adversely affected in its components relevant to the conservation objectives or the protective purpose, according to Section 7, Paragraph 6 in conjunction with Paragraph 7 ROG, the provisions of the Federal Nature Conservation Act on the admissibility and implementation of such interventions, including obtaining the statement of the European Commission, shall be applied when amending and supplementing spatial plans.

The Natura2000 network comprises the sites of Community importance (habitats areas) under the Habitats Directive and the bird protection areas (Special Protection Areas - SPAs) under the Birds Directive, which have now been designated as conservations 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 specific project in knowledge of the specific project parameters, which is carried out within the framework of approval procedures. In this respect, further preventative 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 adverse effect on the conservation objectives of the Natura2000 areas or 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 consideration that for some uses – especially wind energy – the ROP traces the projects already in operation and the designations of the SDP sectoral planning for which impact assessments have already been carried out.

Before being designated as marine areas pursuant to Article 20(2) 57 of the Federal Nature Conservation Act under European law, the nature conservation areas in the EEZ had been included as FFH sites in the first updated list of sites of Community importance in the Atlantic biogeographical region pursuant to Article 4(2) of the Habitats Directive (Official Journal of the EU, 15 January 2008, L 12/1), so an FFH impact assessment had already been performed as part of the Federal Offshore Sectoral Plan for the German North Sea EEZ (BSH 2017). Most recently, an impact assessment according to Section 34 paragraph 1 in conjunction with Section 36 BNatSchG was carried out as part of the SEA for the site development plan (BSH, 2020a).

The German EEZ of the North Sea contains the nature conservation areas “Sylt Outer Reef – Eastern German Bight” (Regulation on the establishment of the nature conservation area “Sylt Outer Reef – Eastern German Bight” of 22 September 2017), “Borkum Reef Ground” (Regulation on the establishment of the nature conservation area “Borkum Reef Ground” of 22 September 2017) and “Dogger Bank” (Regulation on the establishment of the nature conservation area “Dogger Bank” of 22 September 2017).

The total area covered by the three nature conservation areas in the German North Sea EEZ is 7,920 km^2, of which 625 km^2 is covered by the “Borkum Reef Ground” nature conservation area, 5,603 km^2 by the “Sylt Outer Reef – Eastern German Bight” nature conservation area and 1,692 km^2 by the “Dogger Bank” nature conservation area.

Within the framework of the impact assessment, the habitat types “reef” (EU code 1170) and “sandbank” (EU code 1110) according to Appendix I of the Habitats Directive with their characteristic and endangered biotic communities and species as well as protected species, specifically fish (river lamprey, twaite shad), marine mammals according to Appendix II of the Habitats Directive (harbour porpoise, grey seal, and harbour seal) as well as protected bird species according to Appendix I of the Birds Directive (in particular red-throated diver, black-throated diver, little gull, Sandwich tern, common tern, and Arctic tern) and regularly occurring migratory bird species (in particular common and lesser black-backed gull, northern fulmar, northern gannet, kittiwake, guillemot, and razorbill) are to be observed.

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 remote effects insofar as these exist. It therefore does not replace the assessment at the level of the specific project. Depending on the designations of the ROP for the respective use, the assessment is stratified. A staged planning and approval process occurs for wind energy. This means that the reviews of the downstream planning levels are taken into consideration within the framework of this ROP. If no review has yet been carried out at subordinate planning levels, the review within the framework of this SEA for the Spatial Plan is carried out on the basis of the available data and knowledge.

There is also a staged planning and approval process for the extraction of raw materials. Where data and knowledge are available, an impact assessment is carried out as part of this SEA; otherwise, the assessments are reserved for the downstream planning levels.

The Spatial Plan contains provisions relevant to the impact assessment concerning priority and reservation areas for wind energy, reservation areas for pipelines and power cables, and reservation areas for hydrocarbons, sand and gravel extraction. The same applies to cables/pipelines. Scientific designations can be examined only as far as information is available.

A differentiation must be made for the impact assessment:

Wind Energy

Since the technical legislation under Section 5 subsection (3) sentence 5 point a) of Germany's Offshore Wind Energy Act (WindSeeG) prohibits areas and sites chosen for wind energy installations in the Spatial Plan from being within a protected area designated under Article 57 of the Federal Nature Conservation Act (BNatSchG), the Spatial Plan does not contain any area definitions for the use of wind energy within the protected areas designated by such regulation.

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 SDP 2019 and SDP 2020.

Raw material extraction

The reservation areas for sand and gravel extraction SKN1 and SKN2 lie within the "Sylter Außenriff - Östliche Deutsche Bucht" nature conservation area and the reservation area for hydrocarbons KWN1 lies partly within and otherwise spatially adjacent to the "Doggerbank" nature conservation area.

Where operating plans have already been issued, e.g. for the main operating plan OAMIII in the SKN1 sand and gravel extraction reservation area, a compatibility assessment has already been carried out. For this reason, no separate assessment is carried out here in this SEA.

In all other respects, the impact assessment is reserved for the downstream procedures (i.e. in particular the procedures for applying for a main operating plan).

Lines

The reservation area LN6 crosses the nature conservation area "Borkum Riffgrund". The reservation areas LN1 and LN14 run within the "Doggerbank" nature conservation area.

Strategic uses

The FoN2 reservation area is located within the nature conservation area "Sylter Außenriff - Östliche Deutsche Bucht". As it is only a matter of sampling fish and thus of selective activities without additional burdens, no impact assessment is carried out. Please refer to Chapter 4.6.

According to Section 34 subsection 2 in conjunction with section 36 BNatSchG, the plan is inadmissible if the impact assessment shows that the specifications may lead to significant negative impacts on a Natura 2000 site in its components relevant to the conservation or protection objectives.

Projects and plans located outside of protected areas must also be examined for their compatibility with the protective purpose of the respective ordinance as "surrounding projects" (LANDMANN/ROHMER, Section 34 BNatSchG, marginal no. 10) (cf e.g. Section 5, Paragraph 4 NSGBRgV.

6.2 Impact assessment with regard to habitat types

Due to the exclusion by sectoral legislation of areas and sites for wind energy in the FEP in nature conservation areas, construction, installation and operational impacts on the FFH habitat types "reef" and "sandbank" with their characteristic and endangered biocoenoses and species can be excluded. The areas lie far outside the drift distances discussed in the literature so that no release of turbidity, nutrients, and pollutants that could adversely affect the nature conservation and FFH areas in their components relevant to the conservation objectives or the conservation purpose is to be expected.

Whether the designations lead to adverse effects on habitat types must be assessed prognostically, taking into consideration project-specific effects.

For the sections of the 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 in accordance with Lambrecht & Trautner (2007) and Bernotat (2013) are not exceeded.

6.3 Impact assessment with regard to protected species

6.3.1 Impact assessment according to the ordinance on the designation of the "Borkum Riffgrund" nature conservation area

Description of the region

The nature conservation area "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. Water depths range from 18 to 33 metres. It is part of the interconnected European ecological network "Natura 2000" and registered as an area of community importance (under the identification number DE- 2104301) according to the Habitats Directive. In the west, the nature conservation area borders with the Netherlands and in the south with the German territorial waters (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 biotic communities of the sandbank with predominantly medium to coarse sands.

The official announcement of the management plan for the "Sylt Outer Reef - Eastern German Bight" nature conservation area in the German

EEZ of the North Sea took place with the publication in the Federal Gazette on 13 May 2020 (BAnz AT 13 May 2020 B11, management plan for the "Borkum Riffgrund" nature conservation area (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 conservation area

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 Saxon Wadden Sea National Park as well as to the east. The area stands out clearly from its surroundings because of the diversity of the seabed. In the area there is a significant and representative occurrence of the FFH-habitat type "sandbanks with only slight permanent overtopping by seawater", which has diverse substrates and structures and is closely intermeshed with rocky reefs (FFH habitat type "reefs"). This diversity is an important prerequisite for the development of a soil fauna rich in species and individuals. This provides a rich food base for fish, which, in turn, serve as a food source for the FFH-species harbour porpoise and grey seal, among others. In some cases, there are close functional interrelationships between the Borkum Riffgrund nature conservation area and the other marine protected areas in the German EEZ of the North Sea – the "Sylt Outer Reef - Eastern German Bight" and "Doggerbank" nature conservation areas – as well as with marine protected areas of the coastal federal states and littoral states – especially the "Lower Saxon Wadden Sea National Park". In this way, the "Borkum Riffgrund" nature conservation area contributes to the coherence of the Natura 2000 network. Because of its diverse and interconnected habitat structures and high biological diversity, the "Borkum Riffgrund" nature conservation area plays a special role in 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 (Section 3, Paragraph 2, No. 4 NSGBRgV) for the networking of benthic species of sandy habitats in the German North Sea. Reefs also assume such a stepping stone function for reef species (BAnz AT 13 May 2020 B11, management plan for the "Borkum Riffgrund" nature conservation area (MPBRg)).

Legacy impacts and/or threats/impacts and anthropogenic activities are mentioned in the standard data sheet under No. 4.3 (SDB 2020, Official Journal of the EU, L 198/41) and in the management plan. In accordance with the information from the standard data sheet, anthropogenic activities take place within the area. These include shipping, military exercises, oil and gas exploration, power lines, fishing, water sports, and other uses. Pollution entering the area from outside includes marine water pollution and air pollution.

Protected habitats

In the "Borkum Riffgrund" nature conservation area, the habitat types listed in Appendix I of Directive 92/43/EEC that characterise the area are in accordance with Section 3, Paragraph 3 NSGBRgV:

- sandbanks with only slight permanent overtopping by seawater (EU code 1110) and
- reefs (EU code 1170)

In order to protect the habitat types mentioned in paragraph 3, Number 1, including their characteristic species, Section 3, paragraph 4 NSGBRgV sets targets for the conservation or, where necessary, the restoration

1. of the ecological quality of the habitat structures and their areal extent
2. of the natural quality of the habitats with largely natural distribution, population density, and dynamics of the populations of the

characteristic species and the natural expression of their biotic communities
3. of the unfragmented nature and mosaic-like interconnectedness of the habitats and their function as
regeneration space, especially for benthic fauna
4. of the function as a starting point and dispersal corridor for the recolonisation of surrounding areas by benthic species and communities
5. of 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 mammals

Three marine mammal species occur in the Natura2000 area “Borkum Riffgrund” in varying degrees of abundance: Harbour porpoise, seal, and grey seal (Amtsblatt der Europäischen Gemeinschaften, Nr. L 198/41, DE2109301, SDB vom 07/2020):

Phocoena phocoena (harbour porpoise): The data quality is rated as good and is based on surveys. The stock in the area ranges between 251 and 500 individuals and thus, in accordance with the standard data sheets of 07/2020, represents only 0 to 2% of the local population of the German EEZ in the North Sea. Because of the existing pressures, the conservation status is given as average. The population is not isolated within the range but rather at the edge of the distribution area. The overall assessment results in a good value.

Phoca vitulina (seal). The data quality is rated as poor or a rough estimate. The population in the area ranges between 11 and 50 individuals and represents a small proportion of 0 to 2% of the estimated local population. A good state of conservation 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 stock is estimated at 0 to [X] individuals. A good state of conservation is given. The population is not isolated within the range. The overall assessment results in a good value because of the uncertainties mentioned.

Among marine mammal species, the harbour porpoise has a significant occurrence in the nature conservation area and is considered an indicator or key species with regard to the assessment of impacts of the plan from a nature conservation perspective. The noise abatement concept of the BMU (2013) provides the framework for assessing the impacts of offshore wind farms and associated infrastructure in terms of territorial protection to meet the requirements from the national implementation of the Habitats Directive (92/43/EEC) or BNatSchG. In the context of the implementation of the Marine Strategy Framework Directive (MSFD, 2008/56/EC), the harbour porpoise is also used nationally as well as regionally in the framework of the OSPAR and HELCOM Conventions as an indicator species for the assessment of anthropogenic impacts such as those caused by offshore wind farms. From a nature conservation perspective, the use of indicator species is a common procedure to analyse and evaluate anthropogenic impacts with the necessary depth and to take measures to protect marine habitats and species as required.

Pursuant to Section 5 subsection 6 NSGBRgV, the requirements of Section 5 subsection 4 NSGBRgV must be observed in the present assessment.

The assessment of the impact of the plan will be based on the protection purposes of the nearest conservation area "Borkum Riffgrund".

In accordance with Section 3, paragraph 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, and 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 shell layers, and the stocks of harbour porpoises, grey seals, and 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 Section 3, Paragraph 5, No. 1 to 5 NSGBRgV, the ordinance sets out objectives to ensure the conservation and restoration of the marine mammal species listed in Section 3, Paragraph 2 NSGBRgV (harbour porpoise, harbour seal, and grey seal) as well as to conserve and, where necessary, restore their habitats.

Conservation and restoration:

- No.1: of the natural population densities of these species with the aim of achieving a favourable conservation status, their natural spatial and temporal distribution, health status and reproductive fitness, taking into account natural population dynamics and genetic exchanges with populations outside the area
- No. 2: of the area as a largely undisturbed habitat, unaffected by local pollution, of the species of marine mammals referred to in Paragraph 3, No. 2 and, in particular, as a habitat of supraregional importance for harbour porpoises in the area of the East Frisian Wadden Sea,
- No. 3: of undissected habitats and the possibility of migration of the species of marine mammals referred to in subsection 3 number 2 NSGBRgV within, in particular to neighbouring conservation areas of the Wadden Sea and off Helgoland,
- No. 4: of the essential food sources of the species of marine mammals referred to in subsection 3 number 2 NSGBRgV, in particular the natural population densities, age-group distributions and distribution patterns of the organisms serving as food sources 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 (Chapter 3 and Chapter 4) has shown that 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 abatement measures are taken.

The current data sources on the occurrence of harbour porpoises in the German EEZ of the North Sea and also in the "Borkum Riffgrund" nature conservation area was presented in Chapter 2.8.1 and can be described as very good. A very good data source is also available for the assessment of possible impacts of offshore wind farms based on the results from effect monitoring for compliance with orders from permits and planning approval decisions.

The proven sensitivity of harbour porpoises to impulsive noise is crucial for the assessment of the adverse effect on the conservation objectives of the area as well as for the design of appropriate avoidance and mitigation measures. The particular importance of the harbour porpoise as a key species for assessing the impacts of offshore wind farms on the living marine environment was also highlighted in the context of designating the noise abatement concept for the harbour porpoise in the North Sea (BMU, 2013). According to the current state of 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 conservation area "Borkum Riffgrund" (EU code: DE 2104-301).

Please refer to the results of the impact assessments on SDP 2019 and SDP 2020.

Possible negative impacts on the protection purposes of the nature conservation area "Borkum Riffgrund" by the implementation of projects in areas EN1, EN2 and EN3 of the present plan can be reliably excluded if the instructions 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 according to Sections 36, 34 BNatSchG in connection with the conservation purposes of the nature conservation area "Borkum Riffgrund" with regard to marine mammals is not required because of the distance of these areas of the plan from the nature conservation area.

6.3.2 Impact assessment in accordance with the ordinance on the designation of the "Sylt Outer Reef - Eastern German Bight" nature conservation area with regard to marine mammals and protected bird species

Description of the region

The "Sylt Outer Reef - Eastern German Bight" nature conservation area has an area of 5,603 km^2 and is located in the southern North Sea. It includes the outer grounds off Sylt and Amrum and the moraine ridge of the north-eastern flanks of the Elbe glacial valley. The nature conservation area is divided into two areas, I and II, with area I comprising the "Sylt Outer Reef" and area II the "Eastern German Bight". Area I contains sub-areas Ia and Ib. The site of area I encompasses 5311.30 km^2 and that of area II 3133.39 km^2.

Protective purpose of the area

The protective purpose for the entire "Eastern German Bight" nature conservation area is formulated in Section 3 NSGSylV.

In accordance with Section 3 NSGSylV, the protective purpose is:

(1) the achievement of the conservation objectives of Natura 2000 areas through the permanent preservation of the marine area, the diversity of its habitat types, communities, and species relevant to these areas, and the special character of the shallow water areas of the southern North Sea off the North Frisian Islands and the adjacent slope areas of the Elbe glacial valley to the west,

(2) the conservation or, where necessary, the restoration of the specific ecological values and functions of the area, 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 shell layers as well as the development of silt layers with burrowing ground mega-fauna,
   3. the stocks 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 (sub-area 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 (sub-area Ib), as well as
5. the function for the interconnectedness of the benthic communities in the German Bight.

The official announcement of the management plan for the “Sylt Outer Reef - Eastern German Bight” nature conservation area in the German EEZ of the North Sea occurred with the publication in the Federal Gazette on 13 May 2020 (BAnz AT 13 May 2020 B11, management plan for the “Sylt Outer Reef - Eastern German Bight” nature conservation area (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 interrelationships between the “Sylt Outer Reef - Eastern German Bight” nature conservation area and the marine protected areas of the coastal federal states and littoral states. There are also interrelationships with the other marine protected areas in the German EEZ of the North Sea. Because of 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 waters. The reefs in particular act as stepping stones to the reefs of Helgoland and ensure the presence of characteristic species with a large radius of action. For the harbour porpoise, the protected area represents an important migration habitat, which is networked with "Doggerbank", "Borkum Riffgrund", and the so-called "Harbour Porpoise Protected Area", among others. Also because of its importance for numerous seabird species, the “Sylt Outer Reef - Eastern German Bight” nature conservation area contributes to the coherence of the Natura 2000 network (BAnz AT 13 May 2020 B11, MPSyl).

Legacy impacts and/or threats/impacts and anthropogenic activities are mentioned in the standard data sheet under No. 4.3 (SDB 07/2020, Official Journal of the EU, L 198/41) and in the management plan. In accordance with the information from the standard data sheet, anthropogenic activities take place within the area. These include sand and gravel mining, shipping, military exercises, oil and gas exploration, power lines, fishing (weirs, baskets, angling), water sports, and other uses. Pollution entering the area from outside includes marine water pollution and air pollution.

According to Section 7, Paragraph 6 NSGSylV, the specifications according to Section 7, Paragraph 1 and Paragraph 4 NSGSylV must be observed for the plan in question, which must be taken into consideration in the official decision. Prior to their approval or implementation, projects and plans are to be examined for their compatibility with the conservation objectives of a conservation area if, either individually or in combination with other projects or plans, they are likely to have a significant impact on the conservation area.

The assessment of the impacts of the plan is based on the protection purposes of the nature conservation area "Sylter Außenriff – Östliche Deutsche Bucht". In accordance with Section 1 NSGSylV, the nature conservation area combines the areas under the Habitats Directive “Sylt Outer Reef” and the European bird conservation area “Eastern German Bight” and is divided into two areas in accordance with Section 2, Paragraph 4 NSGSylV: Area I designates the "Sylter Außenriff" area, while Area II designates the "Östliche Deutsche Bucht" area.

According to Section 3, Paragraph 1 NSGSylV, the protective purpose is to achieve the conservation objectives of the Natura 2000 areas. Under Section 3 subsection 2 number 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, seals and seabird species, as well as their habitats and natural population dynamics, must be protected.

Protected habitat types:

For the protection of the habitat types specified in Section 4, Paragraph 1, No. 1, including their characteristic species, the conservation or, where necessary, the restoration of the following aspects is required in particular:

1. of the ecological quality of the habitat structures and their areal extent
2. of 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
the unfragmented nature of the habitat and its function as a regeneration area, especially for benthic fauna
4. of the function of the area as a starting point and dispersal corridor for the recolonisation of surrounding areas by benthic species and communities.

Protected marine mammal species

Area I of the “Sylt Outer Reef - Eastern German Bight” nature conservation area is congruent with the Natura 2000 area “Sylt Outer Reef” (DE 1209-301). Area I has a size of 5,314 km².

Three marine mammal species occur in the Natura2000 area “Sylter Außenriff” in varying degrees of abundance: Harbour porpoise, seal, and grey seal (Amtsblatt der Europäischen Gemeinschaften, Nr. L 198/41, DE2109301, SDB vom 07/2020):

Phocoena phocoena (harbour porpoise): The data quality is rated as good and is based on surveys. The population at the area ranges between 1001 and 10000 individuals; compared with the local population, the relative size or density of the population at the site ranges from 15 to 100%. Good conservation is a given. The population is not isolated within the range. The overall assessment results in an excellent value.

Phoca vitulina (seal). The data quality is rated as poor. The population in the area ranges between 101 and 250 individuals; compared with the local population, the relative size or density of the population at the site is estimated to be between 0 and 2%. Good conservation is a 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 in the area is between 11 and 50 individuals, and the relative size or density of the population at the site compared with the local population is estimated to be between 0 and 2%. Good conservation is a given. The population is not isolated within the range. The overall assessment results in a good value.

The Natura2000 area “Sylter Außenriff” is the most important area for harbour porpoises in the German North Sea. The area has a special function as a nursery 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 the current state of knowledge, the habitat types of Appendix I of the Habitats Directive “reef” (EU code 1170) constitute a share of 2.9% and “sandbank” (EU code 1110) a share of 1.7%.

Representative and characteristic benthic communities for the habitat types “sandbank” and “reef” occur in the area. In terms of 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 occurrences of various threatened biotopes. 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 Appendix II of the Habitats Directive, other characteristic species are also listed in the standard data sheet.

Finally, under Section 4, Paragraph 3, No. 1 to 5 NSGSylV, the ordinance sets out objectives to ensure the conservation and restoration of the marine mammal species harbour porpoise, harbour seal, and grey seal mentioned in Section 3, Paragraph 2 NSGSylV as well as the conservation and restoration of their habitats in area I.

Conservation and, where necessary, restoration:

- No.1: of 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 population in the area and genetic exchanges with populations outside the area,
- No. 2: of the area as a habitat largely free of disturbance and unaffected by local pollution of the species of marine mammals referred to in subsection 1 number 2 and, in particular, as a particularly important reproduction, rearing, feeding and migration habitat for harbour porpoises in the Southern North Sea area,
- No. 3: of undissected habitats and the possibility of migration of the species of marine mammals referred to in subsection 1 number 2 into Danish waters, into the immediately adjacent Schleswig-Holstein harbour porpoise conservation area and into the Wadden Sea and Heligoland conservation areas
- No. 4: of the essential food sources of the species of marine mammals referred to subsection 1 number 2, in particular the natural population densities, age-group distributions and distribution patterns of the organisms serving as food sources 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 conservation area and is considered an indicator or key species with regard to the assessment of impacts of the plan from a nature conservation perspective. The noise abatement concept of the BMU (2013) provides the framework for assessing the impacts of offshore wind farms and associated infrastructure in terms of territorial protection in order to meet the requirements from the national implementation of the Habitats Directive (92/43/EEC) or BNatSchG. In the context of the implementation of the Marine Strategy Framework Directive (MSFD, 2008/56/EC), the harbour porpoise is also used nationally as well as regionally in the framework of the OSPAR and HELCOM Conventions as an indicator species for the assessment of anthropogenic impacts such as those caused by offshore wind farms. From a nature conservation perspective, the use of indicator species is a common procedure to analyse and evaluate 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 (Chapter 3 and Chapter 4) has shown that 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 abatement measures are taken.

The current data sources on the occurrence of harbour porpoises in the German EEZ of the North Sea and also in the "Sylt Outer Reef - Eastern German Bight" nature conservation area was presented in Chapter 2.8.1 and can be described as very good. A very good data source is also available for the assessment of possible impacts of offshore wind farms based on the results from effect monitoring for compliance with orders from permits and planning approval decisions.

The proven sensitivity of harbour porpoises to impulsive noise is crucial for the assessment of the adverse effect on the conservation objectives of the area as well as for the design of appropriate avoidance and mitigation measures. The particular importance of the harbour porpoise as a key species for assessing the impacts of offshore wind farms on the living marine environment was also highlighted in the context of designating the noise abatement concept for the harbour porpoise in the North Sea (BMU, 2013). According to the current state of 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 reservation area for harbour porpoise in the German EEZ of the North Sea. The reservation area represents the main concentration area of the harbour porpoise during the sensitive period from 1 May to 31 August, which was identified during the development of the BMU noise abatement concept (2013). The seasonal reserve for harbour porpoises covers Area I of the "Sylt Outer Reef – Eastern German Bight" nature conservation area and its surroundings. From a physical point of view, the reservation area thus generously encompasses the area of the frontal system west of the North Frisian Islands. Weather and currents cause the frontal system to spread very dynamically into the protected area, ensuring increased productivity and a rich food supply for top predators such as harbour porpoises and many seabird species. By designating the seasonal reservation area, the spatial plan takes a preventive measure to safeguard the food-rich alternative habitat of the harbour porpoise outside Area I of the nature conservation area.

Nevertheless, according to the current state of knowledge, effects of noise-intensive pile driving in the immediate vicinity of the nature conservation area are to be expected if no noise-preventing and noise-reducing measures are taken. The exclusion of significant impacts, in particular as a result of disturbance of the stocks in the nature conservation area and the population of the respective species, requires the implementation of strict noise abatement measures. The updating of the plan includes a number of principles in this respect. In the course of the species protection assessment, noise abatement measures were also specified in accordance with the state of the art in science and technology, the application of which, according to the current state of knowledge, rules out the possibility of significant disturbance to the populations 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 SDP 2019 and SDP 2020.

The assessment of the potential impact of the plan has shown that the laying and operation of cable systems will not have significant adverse effects on marine mammals in the vicinity of the cable routes. An adverse effect on the protection purposes of the nature conservation area “Sylter Außenriff – Östliche Deutsche Bucht” by the laying and operation of submarine cables both inside and outside the nature conservation area in compliance with the planning principles of the SDP and taking into consideration appropriate measures in the course of implementation can be ruled out with the necessary certainty.

Any adverse effects on the conservation objectives of area I of the “Sylt Outer Reef - Eastern German Bight” nature conservation area resulting from 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.

Possible negative impacts on the protection purposes and conservation objectives of the nature conservation area "Sylter Außenriff -Östliche Deutsche Bucht" by the implementation of projects in the remote areas EN1 to EN3, EN6 to EN10 and EN12 as well as EN14 to EN18 and EN19 of the present plan can be reliably excluded due to the distance from the nature conservation area.

Protected seabird and resting bird species

The EU bird conservation area “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 km^2.

The “Sylt Outer Reef - Eastern German Bight” nature conservation area represents 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 Appendix II of the Habitats Directive). The nature conservation area is also characterised by occurrences of the habitat types "sandbank" and "reef" as well as various threatened biotopes. The standard data sheet lists as relevant components of the site six bird species listed in Appendix I of the V-RL Birds Directive and 12 regularly occurring migratory bird species not included in Appendix I of the V-RL Birds Directive (standard data sheet DE 1011 401 of 07/2020, Official Journal of the EU, L 198/41, 4.2 Quality and importance).

According to Section 5 subsection 1 number 1 of the NSGSylV, the conservation or, where necessary, the restoration to a favourable conservation status of bird species listed in Annex I of the Birds Directive and regularly occurring migratory bird species occurring in this area are part of the protection purposes of the nature conservation area.

The species mentioned under Section 5 subsection 1 number 1 NSGSylV include the species red-throated diver (Gavia stellata, EU code A001) and black-throated diver (Gavia arctica, EU code A002).

The ordinance then sets out objectives for Area II under Section 5 subsection 2 number 1 to number 4 NSGSylV to ensure the conservation and restoration of the bird species listed in Section 5subsection 1 NSGSylV and the functions of Area II under subsection 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; special attention must be paid to bird species with negative trends in their biogeographical population

- No.2: of the main organisms serving as food for bird species, in particular their natural population densities, age-group distributions and distribution patterns
- No.3: of the increased biological productivity at vertical fronts, which is characteristic of the area, and the geo- and hydromorphological characteristics with their species-specific ecological functions and effects, and
- No.4: of the natural quality of habitats with their respective species-specific ecological functions, their fragmentation and spatial interrelationships, and unimpeded access to adjacent and neighbouring marine areas.

In addition, the update of the SDP provides for establishment of a reserved area for divers in the German North Sea EEZ. The reservation area represents the main concentration area of divers during spring in the German EEZ; this was identified during the preparation of the position paper of the BMU (2009). The protected area covers Area II of the nature conservation area “Sylt Outer Reef – Eastern German Bight” and its surroundings. From a physical point of view, the reservation 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 reservation area and ensures increased productivity and a rich food supply for top predators such as divers but also many other species of seabirds. By designating the reservation area, the spatial plan takes a preventive measure to safeguard the food-rich alternative habitat of the diver outside Area II of the nature conservation area.

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 SDP 2019 and SDP 2020.

As a result, a significant negative impact on the protection purposes of Area II of the nature conservation area "Sylter Außenriff -Östliche Deutsche Bucht" by the implementation of the plan with regard to areas EN11 and EN13 can be safely ruled out.

According to the current state of knowledge, areas EN1 to EN3, EN6 to EN10, EN12, EN14 to EN18 and EN19 are of no significance with regard to the occurrence of divers in Area II of the nature conservation area "Sylter Außenriff - Östliche Deutsche Bucht" due to their distance away from the area.

Examination of the potential effects of the plan has shown that the laying and operation of cable systems will not have a significant adverse impact on bird species in the vicinity of the cable routes. A negative impact on the protection purposes of the nature conservation area "Sylter Außenriff -Östliche Deutsche Bucht" by the laying and operation of cables in compliance with the planning principles of this plan and taking into account appropriate measures in the context of its implementation can be safely ruled out.

A significant negative impact on the protection purposes and conservation objectives of Area II of the nature conservation area "Sylter Außenriff -Östliche Deutsche Bucht" 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 from the area.

As a result, a significant adverse effect on the protective purposes of area I of the “Sylt Outer Reef - Eastern German Bight” nature conservation area can be ruled out with necessary certainty by implementing the plan and taking into consideration avoidance and mitigation measures.

6.3.3 Impact assessment according to the ordinance on the designation of the “Doggerbank” nature conservation area

Description of the region

The “Doggerbank” nature conservation area was established by the ordinance of 22 September

2017 ("Ordinance on the designation of the "Doggerbank" nature conservation area, Federal Law Gazette I, I S, 3400").

The "Doggerbank" nature conservation area 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 includes the German portion of the largest sandbank in the North Sea, which stretches from the UK continental shelf to the Danish EEZ.

The sandbank occupies almost the entire protected area. The water depth is between 28 m and 48 m.

Doggerbank represents a biogeographical divide because of 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 seabed is largely composed of fine shell-rich sands; these 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 May 2020 B11, management plan for the "Doggerbank" nature conservation area (MPDgb)).

Protective purpose and conservation objectives

The protective purpose for the entire "Eastern German Bight" nature conservation area is formulated in Section 3 NSGDgbV. In accordance with Section 3 NSGDgbV, the protective purpose is:

(1) The protection of the marine area as a nature conservation area in order to achieve the conservation objectives of the Natura 2000 area 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 Doggerbank 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 specific ecological values and functions of the area, in particular

1. its supra-regionally significant, largely natural hydromorphological conditions, as well as

2. the stocks of harbour porpoise and harbour seal as well as their habitats and natural

population dynamics.

The protective purposes pursued in the nature conservation area for maintenance or, where necessary, restoration of a favourable conservation status are formulated in Section 3, Paragraph 3 NSGDgbV as follows:

1. of the habitat type characterising the area according to Appendix I of Directive 92/43/EEC "sandbanks with only slight permanent overtopping by seawater" (EU code 1110),

2. of the species listed in Appendix II of Directive 92/43/EEC harbour porpoise (Phocoena phocoena, EU code 1351) and harbour seal (Phoca vitulina, EU code 1365).

The official announcement of the management plan for the "Doggerbank" nature conservation area in the German EEZ of the North Sea occurred with the publication in the Federal Gazette on 13 May 2020 (BAnz AT 13 May 2020 B11, management plan for the "Doggerbank" nature conservation area (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 interrelationships between the "Doggerbank" nature conservation area and the other marine protected areas in the German EEZ of the North Sea – the "Sylt Outer Reef - Eastern German Bight" and "Borkum Riffgrund" nature conservation areas – as well as with marine protected areas of littoral states – in particular protected areas in the area of Doggerbank in the EEZ of the Netherlands and Great Britain. In this way, the "Doggerbank" nature conservation area contributes to the coherence of the Natura 2000 network.

Due to the central location of Doggerbank in the North Sea and its high biological diversity, the "Doggerbank" nature conservation area assumes a special function for the conservation and restoration of its protected assets in the biogeographical region. For example, the "Doggerbank" nature conservation area is of great importance for harbour porpoises as a migration, feeding, and reproduction habitat. As far as reproductive success is concerned, the year-round high biological production in parts of the area should be emphasised (BAnz AT 13 May 2020 B11, management plan for the "Doggerbank" nature conservation area (MPDgb)).

Legacy impacts

Legacy impacts and/or 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. In accordance with the information from the standard data sheet, anthropogenic activities, shipping, and fishing take place within the area. Pollution entering the area from outside includes marine water pollution and air pollution.

The plan in question defines 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 "Doggerbank" nature conservation area, Federal Law Gazette I, I S, 3400").

In accordance with Section 7, Paragraph 6 ROG in conjunction with Section 36, 34, Paragraph 2 BNatSchG as well as according to Section 5, Paragraph 6 NSGDgbV, not only projects but also plans must be assessed for their compatibility before they are approved or implemented. If the impact assessment shows that one designation or several designations of the plan may lead to significant adverse effects on the site in its components relevant to the conservation objectives or the protective purpose, they shall not be permitted.

The impacts of the designations of the plan is assessed on the basis of the conservation purposes of the "Doggerbank" protected area.

<u>Protected habitats</u>

In Section 3, Paragraph 4 NSGDgbV, the ordinance specifies conservation and restoration objectives for the protection of the habitat type mentioned in Paragraph 3, No. 1, including its characteristic species, as follows:

(1) of the ecological quality of the habitat structures and their areal extent
(2) of the natural quality of the habitats with largely natural distribution, population density, and dynamics of the populations of the characteristic species and the natural 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
(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.

<u>Protected marine mammals</u>

According to Section 3 subsection 1 NSGDgbV, the protection purpose is to achieve the conservation objectives of the Natura 2000 site. According to Section 3 subsection 2 number 2 NSGDgbV, the conservation and restoration of the specific ecological values and functions of the area, in particular the populations of harbour porpoise and seals and their habitats, and the natural population dynamics are to be protected.

Two marine mammal species occur in the Natura2000 area “Doggerbank” in varying degrees of abundance: Harbour porpoise and seal (Amtsblatt der Europäischen Gemeinschaften, Nr. L 198/41, DE2109301, SDB vom 07/2020):

Phocoena phocoena (harbour porpoise). The data quality is classified as good in accordance with the standard data sheet (Official Journal of the European Union L 198/41, SDB “Doggerbank” 7/2020) because it is based on data collection. The population in the area ranges between 1001 and 10,000 individuals. The proportion of the population in the protected area is 2 to 15% of the local population in the German EEZ. Good conservation is a given. The population is not isolated within the range. The overall assessment results in an excellent value.

Phoca vitulina (seal): The data quality is rated as 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 in accordance with the information from the standard data sheet (SDB “Doggerbank” 7/2020, Official Journal of the European Union).

Under Section 3, Paragraph 1 to 5 NSGDgbV, the ordinance sets out objectives to ensure the survival and reproduction of the marine mammal species listed in Section 3, Paragraph 2 NSGDgbV – harbour porpoise and harbour seal of Appendix II of the Habitats Directive (92/43/EEC) – as well as for the conservation and restoration of their habitats.

Conservation and, where necessary, restoration:

- No.1: of the natural population densities of these species with the aim of achieving a favourable conservation status, their natural spatial and temporal distribution, health status and reproductive fitness, taking into account natural population dynamics and genetic exchanges with populations outside the area
- No 2: 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
- No. 4: of the main foraging organisms of harbour porpoises and harbour seals, in particular their natural population densities, age class distributions, and distribution patterns.

With regard to remote effects, the assessment of the potential impacts of the update of the plan in Chapters 3.2.4 and 4.2.5 has shown that, based on the knowledge available to date, no significant adverse impacts on marine mammals will be associated with the construction and operation of wind turbines or the laying and operation of subsea cables and pipelines. This also applies with regard to marine mammals in reservation areas EN14 to EN18 and EN19 as well as LN1 and LN14.

The proven sensitivity of harbour porpoises to impulsive noise is crucial for the assessment of the adverse effect on the conservation objectives of the area as well as for the design of appropriate avoidance and mitigation measures. The particular importance of the harbour porpoise as a key species for assessing the impacts of offshore wind farms on the living marine environment was also highlighted in the context of designating the noise abatement concept for the harbour porpoise in the North Sea (BMU, 2013). According to the current state of 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 the experience gained so far within the framework of the subordinate planning and licensing procedures, avoidance and mitigation measures are ordered for the noise-intensive installation of the turbines and platforms in accordance with the specifications of the noise abatement concept of the BMU (2013). Special attention is paid to the overall coordination of the noise-intensive work to avoid and mitigate disturbing sound discharges in the area of nature conservation areas. The data sources with regard to areas EN14 to EN19 are so far considerably smaller than is the case for priority areas EN1 to EN13 or for the "Borkum Riffgrund" and "Sylt Outer Reef - Eastern German Bight" nature conservation areas.

Preliminary investigations are carried out within the framework of the subordinate procedures, in particular for determining the suitability of areas. The results of the site investigations are required both to assess the suitability of the sites and to assess the need for additional avoidance and mitigation measures or, where appropriate, adaptation of the measures in place at the time of the present assessment. The assessment of the impacts of wind energy generation in Chapter 3 and Chapter 4 has shown that 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 abatement measures are taken. The exclusion of significant impacts, in particular through disturbance of the local population of the respective species as well as adverse effects on the conservation objectives of the nature conservation area, requires the implementation of strict noise abatement measures. The plan contains a number of principles in this respect. In the context of the species conservation assessment, technical noise abatement measures were also described according to the state of the art in science and technology. The application of these excludes the local population in the German EEZ and the stocks in the nature conservation areas and their habitats according to the current state of knowledge. Since 2008, the BSH has introduced orders in its approval notices that include binding limit values for impulse noise input from pile driving. The introduction of the binding limit values is based on findings on the triggering of temporary hearing threshold shifts in harbour porpoises (Lucke et al., 2008, 2009). Compliance with the limit values (160 dB individual sound event level (SEL05) re 1µPa2s and 190 dB re 1µPa at a distance of 750 m) is monitored by the BSH by applying standardised measurement and evaluation methods.

Since 2011, all pile driving work has been carried out using noise reduction systems. Monitoring of the noise abatement-related measures has shown that they have been very effective since 2014. A significant disturbance of the stocks and habitats and an associated adverse effect on the conservation objectives of the nature conservation areas in the German EEZ of the North Sea can thus be ruled out.

During installation work at the "Doggerbank" nature conservation area, particular care must be taken to ensure that the possibility of migration between habitats in German, Dutch, Danish, and British waters exists.

Any implementation of the planned designations, in particular also of wind energy in Areas EN14 to EN19, is to be expected/adopted well after 2030. In this respect, the technical progress of energy generation in the expected time of realisation can neither be predicted nor described and evaluated.

The target of climate neutrality in Germany, which has been brought forward to 2045, will require an increased expansion of renewable energies. Therefore, further sites for offshore wind energy use are also needed in the EEZ. The federal government will therefore commission studies for the impact assessment of wind power use on Doggerbank with nature conservation objectives.

The assessment of the potential impact of the plan has shown that the laying and operation of cables will not have a significant adverse effect on marine mammals in the vicinity of the cable routes. A negative impact on the protection purposes of the nature conservation area "Doggerbank" by the laying and operation of cables both inside and outside the nature conservation area in compliance with the planning principles of the FEP and taking into account appropriate measures in the course of implementation can be safely ruled out.

According to the current state of knowledge, any adverse effects on the conservation objectives of the “Doggerbank” nature conservation area with regard to remote effects as a result of 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 because of the distance to the protected area.

6.3.4 Natura2000 sites outside the German EEZ

The impact assessment also takes into consideration the remote effects of the designations adopted within the EEZ on the protected areas in the adjacent 12-mile zone and in the adjacent waters of neighbouring countries. This also applies to the assessment and consideration of functional relationships between the individual protected areas and the coherence of the network of protected areas in accordance with Section 56, paragraph 2 BNatSchG because the habitat of some target species (e.g. avifauna, marine mammals) may extend over several protected areas because of their large radius of action.

Specifically, the protected areas “Nationalpark Niedersächsisches Wattenmeer” and the EU bird sanctuary “Niedersächsisches Wattenmeer und angrenzendes Küstenmeer” in the Lower Saxony territorial waters, the “Nationalpark Schleswig-Holsteinisches Wattenmeer”, the “Ramsar-Gebiet Schleswig-Holsteinisches Wattenmeer und angrenzende Küstengebiete“”, the “Steingrund” FFH area and the “Seevogelschutzgebiet Helgoland” in the Schleswig-Holstein territorial waters as well as the Natura2000 area “Sydlige Nordsø” in the Danish EEZ, the Dutch bird conservation area “Friese Front”, and the Dutch FFH area “Doggersbank” are taken into consideration.

The protection and conservation objectives for the Natura 2000 areas outside the EEZ were taken from the following documents:

- - FFH area "Lower Saxony Wadden Sea National Park": Section 2 in conjunction with Annex 5 Law on the National Park “Niedersächsisches Wattenmeer” (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 Waters": Natura2000-Gebiete der Tideweser in Niedersachsen und 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 the Habitats Directive proposal area DE-0916-391 “NTP S-H Wadden Sea and adjacent coastal areas” (http://www.umwelt-

daten.landsh.de/public/natura/pdf/erhaltungsziele/DE-0916-391.pdf)

- - EU Bird Sanctuary "Ramsar Area S-H Wadden Sea and Adjacent Coastal Areas": Conservation objectives for the bird conservation area DE- 0916-491 “Ramsar area S-H Wadden Sea and adjacent coastal areas” (http://www.umweltdaten.landsh.de/public/natura/pdf/erhaltungsziele/DE-0916-491.pdf)
- “Seevogelschutzgebiet Helgoland**”:** Conservation objectives for the bird conservation area DE-1813-491 “Seevogelschutzgebiet Helgoland” **(**http://www.umweltdaten.landsh.de/public/natura/pdf/erhaltungsziele/DE-1813-491.pdf)
- “Steingrund” FFH area Conservation objectives for the area designated as a area of Community importance DE 714-391 “Steingrund” (www.umweltdaten.landsh.de/public/natura/pdf/erhaltungsziele/DE-1714-391.pdf)
- Denmark: FFH and bird sanctuary "Sydlige Nordsø": EUNIS Factsheet (http://eunis.eea.europa.eu/sites/DK00VA347)
- Netherlands: "Friese Front" bird sanctuary: EUNIS Factsheet (https://eunis.eea.europa.eu/sites/NL2016166)
- Netherlands: Habitats Area "Doggersbank": EUNIS Factsheet (https://eunis.eea.europa.eu/sites/NL2008001).

The results of the impact assessment in the context of the designations in the update of the plan according to Section 34 BNatSchG in connection with the conservation purposes of the aforementioned Natura 2000 area with regard to protected species and habitats are also transferable to the Natura 2000 areas in the territorial waters. The assessment of possible adverse effects on the protective purposes and conservation objectives of the Natura 2000 areas in the German EEZ led to the conclusion that significant negative impacts can be excluded with the necessary certainty while taking the principles and objectives of the spatial plan as well as avoidance and mitigation measures ordered in the context of subordinate approval procedures into account. This conclusion is also transferable to the protection purposes and conservation objectives of Natura 2000 areas in the territorial waters. In German waters, the Natura2000 network is structured in such a way that the connectivity of important habitat types and functions (e.g. migration and migration routes in particular) is guaranteed. Appropriate measures for the avoidance and mitigation of significant impacts within the framework of subordinate approval procedures in the German EEZ shall always ensure that no remote effects, including indirect significant adverse effects, are to be expected for the conservation objectives of the Natura 2000 areas in the territorial waters.

6.4 Result of the FFH impact assessment

As a result, significant adverse effects for the protective purposes of the “Borkum Riffgrund”, “Sylt Outer Reef - Eastern German Bight”, and “Doggerbank” nature conservation areas and the protective purposes of the area under the Habitats Directive “Lower Saxon Wadden Sea” can be ruled out with the necessary certainty on account of the update of the plan while taking avoidance and mitigation measures for FFH habitat types, marine mammals, avifauna, and other protected animal groups into account.

It should be noted that the FFH impact assessment carried out here was not able to 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 planning approval procedures 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, significant adverse effects for the FFH 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 “Borkum Riffgrund”, “Sylt Outer Reef - Eastern German Bight”, and “Doggerbank” nature conservation areas as well as for the “Lower Saxon Wadden Sea National Park” in the territorial waters because of the small-scale impacts as well as the distances to the areas.

7 Evaluation of the overall plan

In summary, with regard to the designations of the spatial plan, it applies that through the orderly, coordinated overall planning, the impacts on the marine environment shall be minimised as far as possible. The safeguarding of the nature conservation areas designated by ordinance as priority areas for nature conservation maintains protective purposes and safeguards open space.

The designation of the main concentration area of divers, which is larger in terms of area, as a priority area encompassing Sub-area II of the nature conservation area "Sylter Außenriff – Östliche Deutsche Bucht" may also have a positive impact on other species protected in the nature conservation area or bird conservation area 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 EEZ of the North Sea. Because other uses (military use, sand and gravel extraction) are to have as few adverse effects as possible on the protective purpose of the priority area for divers and because there is to be no interference by sand and gravel extraction or agreement on military use from 1 March to 15 May of any given year, the protection of divers is additionally emphasised.

In addition, by excluding installations above the water surface*, designation 2.4 (5) serves to implement measures to secure the coherence of the Natura 2000 network (coherence measures) with regard to adverse effects emanating from existing wind turbines in the priority or reservation area for divers. In order to enable nature conservation sectoral planning to develop its own compensatory regulation in this respect, the temporary designation 2.4 (5) is made as spatial planning support; through this, the area in question is temporarily protected from conflicting uses. This also supports the protection of divers.

However, according to the current state of knowledge, it must be assumed that the wind farm projects to be realised on EN13 will have scaring effects on the priority area divers to the extent identified and that an individual examination must be performed in order to determine the extent of avoidance and mitigation measures for the installations in the application process. However, overall, the positive effects outweigh the negative impacts because of the designation of the main concentration area as a priority area for divers beyond the protected area "Sylter Außenriff – Östliche Deutsche Bucht" established by ordinance and because of the aforementioned designations on the consideration of conservation purposes. The designation of the reservation areas for divers (StN1 to StN3) simultaneously takes account of the sustainable use of reservation areas EN4 and EN5.

If stricter preventative and mitigation measures are complied with, in particular those for noise mitigation 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 reservation areas for wind energy are identified in the priority areas for nature conservation. The reservation areas for lines also run predominantly outside of ecologically significant 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 interrelationships, that, according to current state of knowledge and at the comparatively abstract level of spatial planning, no significant impacts on the marine environment within the area of investigation are to be expected as a result of the planned designations.

Many environmental impacts, such as those from shipping or fisheries, are independent of the implementation of the spatial development plan and can only be controlled to a very limited extent by spatial planning.

Based on the same medium-term time horizon, most of the environmental impacts of the individual uses for which designations are made would also arise if the plan were not implemented. This is because it is not apparent 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 designations of the plan appear basically “neutral” with regard to their impacts on the environment. Although it is possible in principle that, because of the concentration/bundling of individual uses on certain areas/territories, some plan specifications may well have negative environmental impacts in the area of this specific area, an overall balance of the environmental impacts would tend to be seen as positive because of the bundling effects because the remaining sites/areas are relieved and treats to the marine environment (e.g. risk of collision) are reduced.

In the case of wind energy use, the potential impacts are often small-scale and largely short-term because 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 assets such as bat migration.

For the wind energy reservation areas and the cable/pipeline reservation areas in the area north of shipping route SN10, detailed data and findings are lacking for individual protected assets. The potential impacts can therefore not be conclusively assessed within the framework of the present SEA or are subject to uncertainties and require more detailed examination within the framework of downstream planning stages.

8 Measures to avoid, mitigate, and compensate for significant negative impacts of the spatial plan on the marine environment

8.1 Introduction

In accordance with No. 2 c) Annex 1 to Section 8, paragraph 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 impacts resulting from the implementation of the plan.

In principle, the ROP takes better consideration of the concerns of the marine environment. The designations of the ROP will prevent 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 expand offshore wind energy production and the associated connecting pipelines and power lines exists in any case, and the corresponding infrastructure would have to be created even without the Spatial Plan (cf. Section 3.2). However, in the event of non-implementation of the plan, the uses would develop without the space-saving and resource-conserving steering and coordination effect of the ROP.

Moreover, the designations of the ROP are subject to a continuous optimisation process because the knowledge obtained on a rolling basis within the framework of the SEA and the consultation process is taken into consideration when the plan is compiled.

While individual avoidance, mitigation, and compensatory measures can be implemented at the planning level, others come into effect only during concrete implementation and are regulated there in the individual planning approval on a project- and site-specific basis.

8.2 Measures at the planning level

With regard to planning preventative and mitigation measures, the ROP defines spatial and textual designations that, according to the environmental protection objectives set out in Chapter 1.4, serve to prevent or mitigate significant negative impacts of the implementation of the ROP on the marine environment. This concerns mainly

- the designation of all nature conservation areas in the EEZ established by ordinance as priority areas for nature conservation,
- the designation of the main concentration area of divers as a priority area,
- the designation of the main distribution area of harbour porpoises as the harbour porpoise reservation area,
- refraining from designating priority or reservation areas for wind energy in priority areas for nature conservation,
- the designation of cable/pipeline reservation areas in which lines are to be laid, mainly outside nature conservation priority areas,
- the principle that consideration should be given to existing nature conservation areas when planning, laying, and operating subsea cables and pipelines,
- the principle of noise mitigation in the construction of wind turbines,
- the principle of overall coordination of construction work on energy generation installations and the laying of subsea cables and pipelines,
- the principle of choosing the gentlest possible cable laying procedure when laying subsea cables and pipelines,

- the principle of taking into consideration best environmental practices in accordance with 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 priority area for 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 lines, the aim should be to achieve the greatest possible bundling in the sense of routing them parallel to each other. In addition, the routing should be chosen parallel to existing structures and installations as far as possible.

8.3 Measures at the concrete implementation level

In addition to the measures mentioned in Chapter 8.2 at the plan level, there are measures for the avoidance and reduction of insignificant and significant negative impacts in the actual implementation of the ROP for certain designations or associated uses such as offshore wind energy, subsea cables and pipelines, and sand and gravel extraction. These mitigation and avoidance measures are specified and ordered by the respective competent licensing authority at the project level for the planning, construction, and operation phases.

With regard to the concrete preventative and mitigation measures for offshore wind energy and lines, at least the power cables, reference is made to the explanations in the environmental report on SDP 2019 and SDP 2020. These measures, such as noise abatement for offshore wind turbines, are described in detail in Chapter 8.

Specific preventative 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, and the avoidance of riprap as far as possible as well as 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, restricting extraction trips during times that are sensitive for the diver, stipulating that only ships with a certain sound spectrum be used, ordering that certain rock fields or reef types be excluded from extraction as well as from adverse effects through screening, and strict supervision through appropriate monitoring (cf Chapter 10.2).

9 Examination of reasonable alternatives

9.1 Principles behind assessment of alternatives

9.1.1 General

For the spatial plan, a graduated examination of reasonable alternatives will be carried out. 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 accordance with Article 5, paragraph 1, sentence 1 SEA Directive in conjunction with the criteria in Appendix I SEA Directive and Section 40, paragraph 2, No. 8 UVPG, the environmental report generally contains a brief description of the reasons for the choice of the reasonable alternatives examined.

In describing and assessing the environmental impacts determined according to Section 8, Paragraph 1 ROG, the report shall contain, according to No. 2c Annex 1 to Section 8, Paragraph 1 ROG, information on the alternative planning options that may be considered while taking the objectives and spatial scope of the spatial plan into account.

At the same time, the identification and examination of the planning options or alternative plans to be considered must only relate to what can reasonably be required according to the content and level of detail of the spatial plan. The following applies: The greater the expected environmental impacts and thus the need for conflict management in planning, the more likely it is that extensive or detailed investigations will be required.

By way of example, Appendix 4, No. 2 UVPG refers to the assessment of alternatives with regard to the design, technology, location, size and scope of the project, but explicitly refers only to projects. At the planning level, it is thus primarily the conceptual/strategic design and spatial alternatives that play a role.

In principle, it should be noted that a preliminary examination 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 designation 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 possibilities and alternatives, where relevant for the individual uses.

The SEA and thus also the alternative assessment for the draft Spatial Plan are characterised by a larger scope of investigation and a lower level of detail compared to environmental assessments at subsequent planning and licensing levels.

9.1.2 Examination of reasonable alternatives for the spatial plan

The overarching guidelines first serve as a framework for the selection and assessment of the alternatives. In the early stage of the planning process, three planning options were initially developed as overall spatial planning solutions. From this, various sectoral and sub-spatial planning options were developed and examined parallel to the preparation of the draft plans according to the planning that was taking shape (cf Figure 42).

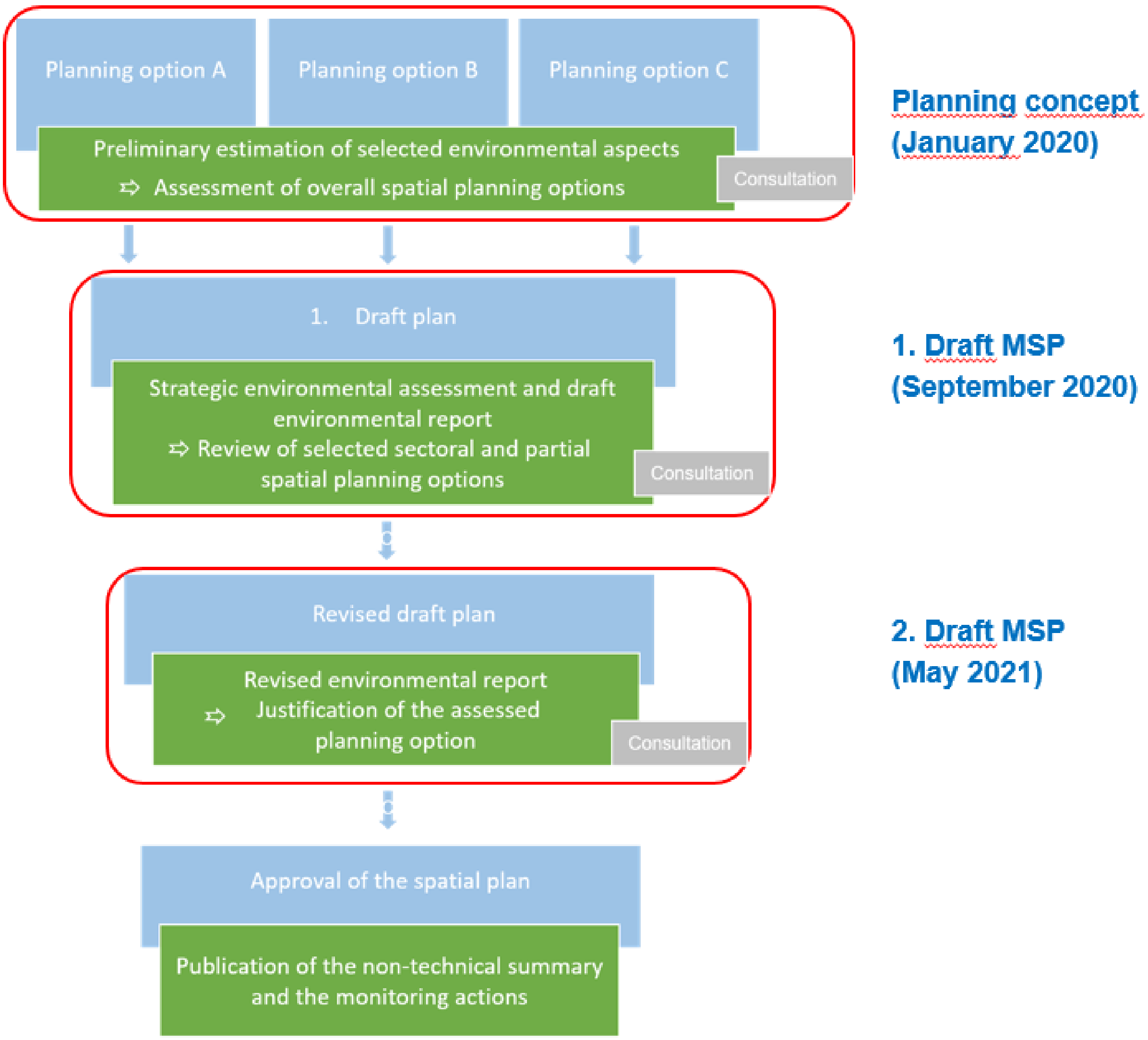


Figure 42: Staged approach to reviewing alternative options.

A mission statement was developed for the spatial plan and guidelines formulated on how the sea can be used and preserved in its diversity. The following overall objectives can be derived from this, against which the planning alternatives considered below are measured.

The spatial plan shall:

- support coherent international maritime spatial planning and territorial cooperation with other countries and at the regional seas level,
- take into account land-sea relations and planning in territorial waters,
- lay the foundations for a sustainable maritime economy in the spirit of Blue Growth, and

- contribute to the protection and improvement of the status 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 requirements, with
- the designation of appropriate areas, in particular for economic and scientific uses, as well as for the marine environment and other concerns,
- a prioritisation of sea-specific uses and functions,
- the balancing of environmental, economic and social concerns,
- the economical and optimised use of areas allocated to uses, especially sites for fixed infrastructure, which also includes reversibility of fixed installations,
- the holistic view of the various activities in the sea,
- their effects and interrelationships as well as cumulative impacts, and
- the application of the ecosystem approach and the precautionary principle.

9.2 Examination of reasonable alternatives within the framework of the planning concept

The planning concept was prepared as a first informal planning step. The concept for the update of the spatial plans in the German EEZ of the North Sea and Baltic Sea included three planning options (A, B, C) as overall spatial plan variants in the early stage of the process of updating the spatial plans. The early and comprehensive consideration of several planning options represents an essential planning and testing step in the update of spatial plans.

The concept for the update presents the use requirements of different sectors from three different perspectives – in the sense of overall plan alternatives. All of these are 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 dependencies and interactions as well as corresponding planning principles were taken into account, and it has been shown how maximum demands of individual sectorshave been limited in this respect.

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

9.2.1 Overview of the planning options

(A) The focus of planning option A is on traditional uses of the sea, with particular attention to the interests of shipping, raw materials extraction and fisheries.

(B) Planning option B shows a climate protection perspective in which a lot of space is given to future use of offshore wind energy.

(C) Planning option C focuses in particular on broadly securing extensive areas for marine nature conservation. In addition to the initial, mainly spatial definitions, there are some supplementary textual definitions.

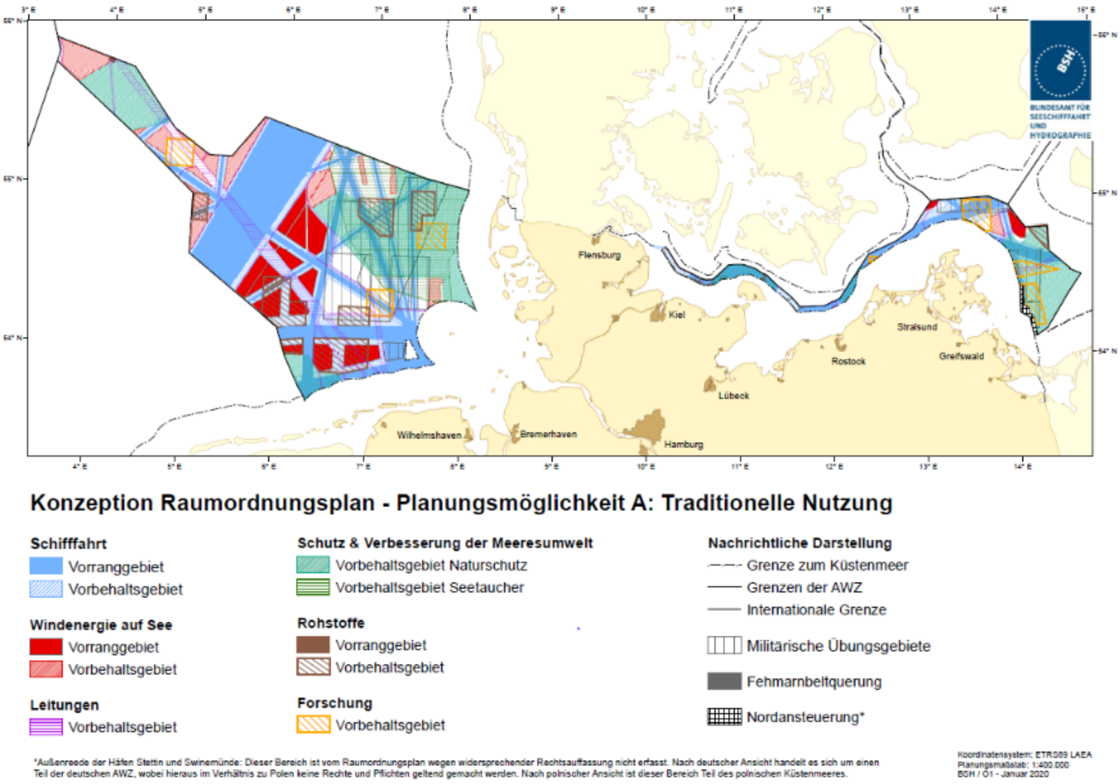


Figure 43: Spatial planning concept – planning option A “Traditional use”

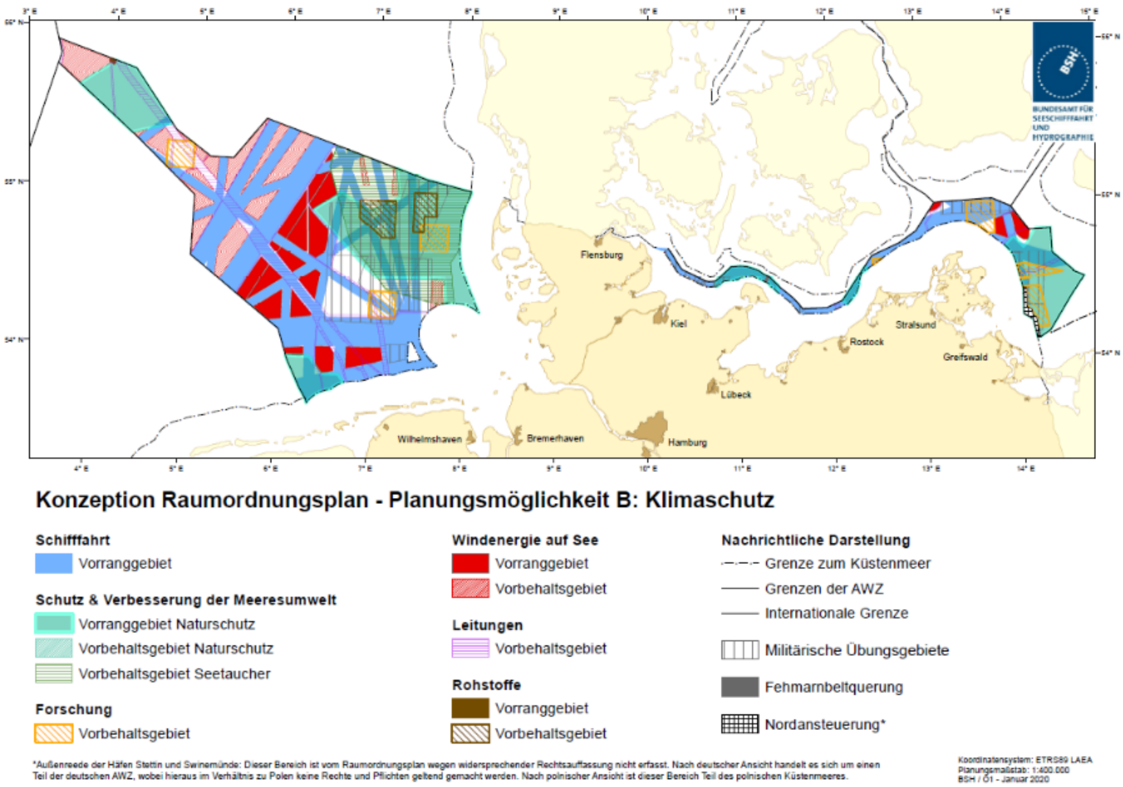


Figure 44: Spatial planning concept – Planning option B “Climate protection”

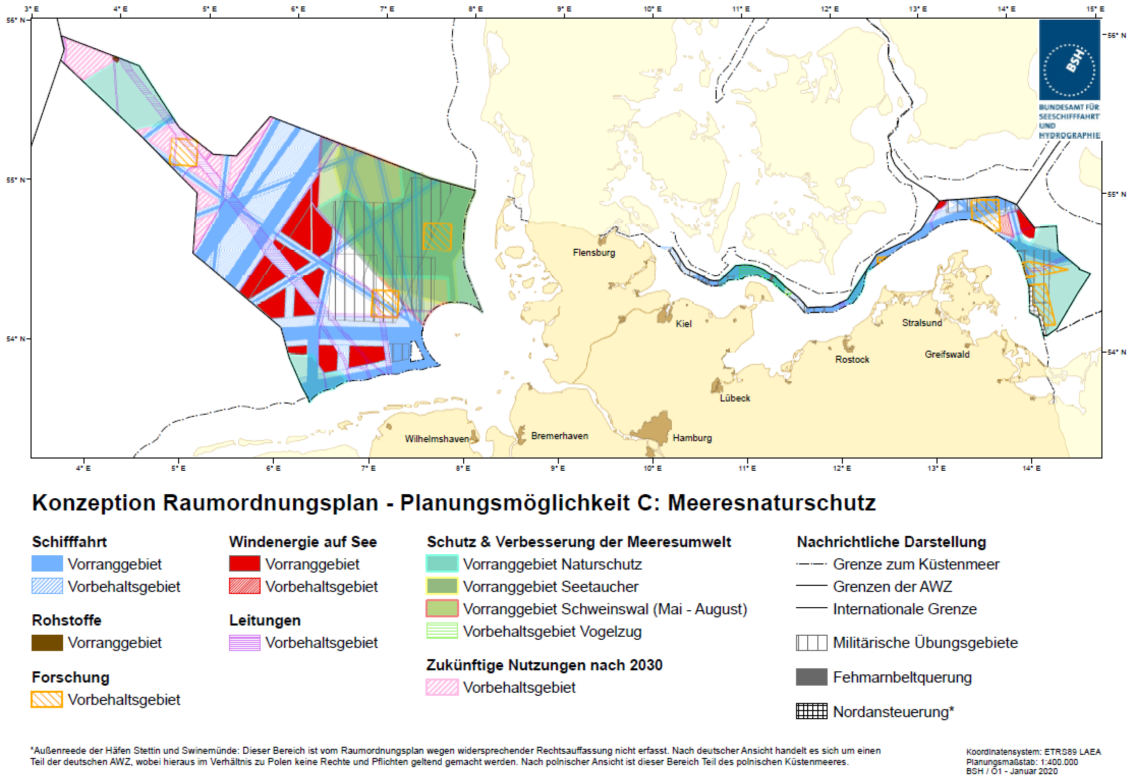


Figure 45: Spatial planning concept – Planning option C "Marine protection"

In addition to general basic assumptions and overarching objectives that applied to all three planning options (cf conception), 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 allowed in combination with other uses as well as in nature conservation areas and should be given special weight in the balancing process. Permit areas in accordance with the Federal Mining Act (BBergG) are defined as reservation areas.

Fisheries

- For fishing, 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

Offshore wind energy

- Comprehensive sites must be secured for the further expansion of offshore wind energy, even beyond 2030, with the largest possible installed capacity for energy generation. To this end, areas for shipping along Route 10 in the North Sea will be designated only 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 reservation areas; however, permit areas for sand and gravel extraction are taken into consideration.

Planning option C

<u>Protection and improvement of the marine environment</u>

- Economic uses not compatible with the purpose of protection in areas earmarked for protection and improvement of the marine environment should be excluded as far as possible.
- Raw materials extraction of sand and gravel, but also of hydrocarbons, should not be privileged by dispensing with spatial definitions for all raw materials.
- For bird migration in the Baltic Sea, a reserved area is established in the area of the Fehmarn-Lolland route.

9.2.2 Environmental assessment of the planning options

The table below lists only those planning topics for which alternative planning solutions have been presented in the planning options. In the assessment of the environmental aspects, primarily impacts that relate to the spatial designations – and here in particular to the differences between the three planning options – are named.

In general, it can be stated from an environmental standpoint that 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 broader priority areas are defined within 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 definitions between the planning options. Here, the extent of the area definitions varies greatly. From a climate protection point of view, this leads to different levels of CO_2 savings potential. Compared with A and C, planning option B offers significantly greater CO_2 savings potential in a relative comparison based on the assumed installed capacity. On the other hand, the three planning options lead to different area use; it ranges 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 reservation areas for offshore wind energy. In general, however, less than 1% of the designated areas are actually sealed.

The nature conservation areas account for a large part of the EEZ area. Over a third of the North Sea EEZ and more than 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 the protection of open spaces because they exclude uses that are incompatible with nature conservation. The quantitative differences in terms of area definitions for the protection and improvement of the marine environment are rather small between the three planning options. The decisive factor is rather the conservation purpose of the designations; for example, in individual plan variants, the main distribution areas of divers and harbour porpoises are designated as a priority area. In this respect, planning option C is to be preferred from the pure perspective of nature conservation and the precautionary principle. However, the climate protection aspect must be taken into consideration here; this 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	Navigation routes as priority areas with accompanying reservation areas	• Some crowding out and bundling effects are to be expected.
B	All shipping routes across the whole width of the area Priority areas; SN10 is divided into three main traffic routes, leaving gaps which are presented as reservation areas for offshore wind energy	• Possibly increased risk of collision with corresponding environmental risks compared to planning options A and C due to reservation areas of wind energy within route SN10, and the concentration of traffic in the remaining corridors, without additional navigation areas.
C	Navigation routes as priority areas with accompanying reservation areas; SN10 along the main traffic flows as priority area Navigation, with remaining gaps as temporary priority area until 2035	• Due to the temporary priority area, there are no additional environmental impacts in the medium term compared to planning option A.
Offshore wind energy / Future uses		
A	Designation of areas as priority and reservation areas for offshore wind energy production for approx. 35 to 40 GW of installed electrical generating capacity; Definition of areas EN1 to EN3, and EN6 to EN12, and EO1 and EO3 as priority areas for offshore wind energy.	• Area use approx. 5,000 km², approx. 15 % of the EEZ of the North Sea and Baltic Sea
B	Sea area allocations with more extensive priority and reservation areas for wind energy, also within SN10 for approx. 40 - 50 GW; Definition of areas EN1 to EN3, and EN6 to EN13 and EO1 to EO3 as priority areas for offshore wind energy.	• Sea area u approx. 6,400 km², approx. 20 % share of the North Sea and Baltic Sea EEZs, considerably larger than in planning option A. • CO_2 savings potential taking into account climate protection aspects: In relation to planning options A and C, the CO_2 savings potentials are significantly greater when capacities for installed power are taken into consideration. • It is possible that a higher risk of collision could result from the location of wind energy areas within the main shipping route 10.

C	Designation of areas with less extensive priority and reservation areas wind energy production for approx. 25 to 28 GW of installed electrical generating capacity; Definition of areas EN1 to EN3, and EN6 to EN12, and EO1 and EO3 as priority areas for offshore wind energy. In the Duck's Bill, reservations areas are designated for future uses; wind energy is only one possible use; No designation of areas for wind energy in the reservation areas for divers (loons) and porpoises.	• In relation to planning options A and B, the CO_2 savings potentials already secured for wind energy by the designations are significantly lower. • At approx. 3,000 km², approx. 9 % of the area used for wind energy, the North Sea and Baltic Sea EEZs account for about 9%, which is significantly lower than in planning options A and B. • In an area of around 1,600 km² or about 6 % of the North Sea EEZ, future use will be kept open, but no prioritisation will be given to offshore wind energy, for example, thus maintaining the option for uses with less environmental impact in the long term. • Subsequent use of wind energy at the sites of the wind farms in the main distribution areas of divers (loons) and harbour porpoises is ruled out, so that a positive long-term environmental impact can be expected compared with the status quo. • Overall, compared with 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	Reservation areas for all permits, for hydrocarbons and areas for sand and gravel extraction	• A possible adverse impact can be caused by avoidance effects and potential physical disturbance / injury by underwater sound during seismic surveys. In addition, there would be possible effects from the construction and operation of production platforms • The following impacts are possible as a result of quarrying in the reservation areas for sand and gravel, which are all located in nature conservation areas: an adverse effect on the seabed through physical disturbance, an adverse effect and avoidance effects through turbidity plumes, habitat modification through substrate removal, and loss of habitat and area.
B	Reservation areas for sand and gravel extraction only	• Fewer adverse effects than in planning option A are to be expected because only designations

		for sand and gravel extraction are envisaged, and there is no prioritisation of hydrocarbon extraction by spatial planning.
C	No specifications for raw materials extraction	• By dispensing with specifications for the extraction of raw materials as a whole, including protected areas, a lower burden can arise compared with planning options A and B, since regional planning does not set any priorities here compared with other uses. In this case, the use is carried out solely on the basis of the operational plans following approval under mining law. 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, reservation areas are shown in the extension of existing nature conservation areas. In addition, the main concentration area of divers (loons) in the North Sea is designated as a reserved area.	• Restrictions in nature conservation areas generally exclude offshore wind energy and thus support the conservation purpose of these areas. In the context of further site development for offshore wind energy and a later update of sectoral planning, nature conservation would be accorded only the weight of a reservation by spatial planning when weighing up the interests. • The restrictions governing the area of the divers (loons) dictate that subsequent use or expansion of wind energy is subject to reservations.
B	Priority areas for nature conservation are defined in the extent of existing nature conservation areas, with the exception of areas overlapping with the reservation areas for sand and gravel extraction. The main concentration area for divers (loons) in the North Sea is defined as a reservation area, as in planning option A.	• The designation of priority areas for nature conservation supports the conservation purposes of the nature conservation areas. However, where specifications for sand and gravel extraction overlap with a nature conservation area, nature conservation is only assigned a reservation. • The use of wind energy in the priority area and in the nature conservation area is excluded. • The restrictions governing the area of the divers (loons) dictate that subsequent use is subject to reservation. • 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 extension of all nature reserves, as well as for the main concentration area of divers (loons) 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 bird migration reserve is defined.	• The designation of the nature reserves as well as the main concentration areas of great cetaceans and harbour porpoises as nature conservation priority areas supports the protection purposes of the nature conservation areas and other areas of outstanding nature conservation importance. As a result, nature conservation is given greater weight when weighing up against other uses within these areas. • The priority of the main concentration area of divers leads to the exclusion of any 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 divers (loons). Wind energy development in the priority area for harbour porpoises is also excluded. • The Fehmarn-Lolland bird migration reserve in the Baltic Sea will serve as an additional definition in support of the MSFD measure to protect migratory species.

9.3 Examination of reasonable alternatives within the framework ofthe planning process

The 1st draft plan was prepared on the basis of the planning conception, the comments received on them, 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.

Parallel to the preparation of the draft plans, the environmental reports were prepared. The alternatives examined were selected mainly on the basis of the planning options presented and the assessment of the environmental impacts (cf also Chapter 5 of the conception*). The designations were taken from the respective planning options but were also spatially adapted in part because of 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 contributed to the comparison and discussion of these in case of conflicting requirements.

It remains the case that the plan must be considered in the overall context in order to ensure that, in addition to taking nature conservation concerns and the avoidance or reduction of possible negative environmental impacts into consideration, the choice of plan solutions also aims to achieve the greatest possible overall balance with other economic and scientific uses and safety concerns. The decisive factor is that the SEA at the level of the designations made in the spatial plan concludes, based on the current state of 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 Spatial Plan, is not considered a reasonable option.

The overarching and forward-looking planning and coordination, taking into consideration a large number of spatial claims, is expected to lead to a comparatively lower overall area use and thus to lower environmental impacts than if the plan were not implemented (cf Chapter 3).

Compared to the 2009 Spatial Plan and the 2019 Site Development Plan, the draft plan includes a designation of reservation areas for wind energy for the long-term expansion of offshore wind energy and thus fulfils a precautionary management of the expansion of offshore wind energy. The inclusion of these areas enables spatially ordered and space-saving planning, taking into account environmental concerns and the interests of other uses. This also applies to the definition of reservation areas for cables andpipelines. Whereas in the 2009 ROP only existing pipelines are defined as reservation areas, the current reservation areas include lines and routes for future connecting cables and interconnectors. These reservation areas are predominantly located outside protected areas and thus have a steering effect on the routing of cables and pipelines 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 with the planning concept, the designations 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 designation of the intermediate areas not as reservation areas but rather as temporary priority areas with conditional transition to reservation areas if no traffic management measures are introduced by 2035

Offshore wind energy designations within Route SN10 are not specified, in particular for reasons of safety and efficiency of navigation.

As a result, there would be less pollution in this area, which would be expected from the construction and operation of the installations, 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, which might have to fall back on these areas are taken by 2035, they would be “downgraded” to reservation areas for shipping.

However, in contrast to planning option C, the general designation of reservation 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 reservation areas for shipping has no influence on potential environmental impacts. The designation of priority areas for shipping within nature conservation areas reflects the existing traffic flows and serves to keep the routes clear. Shipping traffic does not de facto change 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 conservation area, the heavily frequented IMO route Terschelling German Bight had to be taken into consideration and secured in the spatial planning. The conservation area ordinance itself also takes this important shipping function into account for zoning within the area.

Alternative: Shipping	
Brief description	• The areas for shipping are designated as reservation areas in the entire width of the nature conservation areas.
Presentation of the alternative compared with the draft plan	• In the draft plan, all routes, including those in the nature conservation areas, are designated as priority areas.
Points of conflict with other uses	• According to the provisions of UNCLOS to be applied in accordance with Section 1, Paragraph 4 ROG, a restriction of shipping in the EEZ is only possible under the conditions laid down therein. There can thus be no conflict of considerations from a legal point of view. Furthermore, Section 57 subsection 3 number 1 BNatSchG stipulates that restrictions on shipping are not permitted in nature conservation areas • In particular in the nature conservation area Borkum Reefground, the international shipping route in traffic separation scheme Terschelling German Bight would not be adequately safeguarded by spatial planning.
Environmental assessment	• There would probably be no change in the environmental impact of shipping, because the freedom of navigation and, in the traffic separation schemes, for large vessels calling at seaports, the obligation to use them, would continue to exist. • No regulations can be established via spatial planning to avoid certain areas or to change the routing in nature conservation areas. However, the number of ship movements outside the traffic separation scheme, especially in the Sylter Außenriff, is rather low. • The priority areas for shipping are mainly intended to keep the important shipping routes clear of fixed installations and are therefore complementary to the priority areas for nature conservation in their regulatory purpose of preventing accidents.

9.3.2.2 Offshore wind energy

The spatial designations of planning option A are used for offshore wind energy. This option offers sufficient safeguarding of areas for the objectives of wind energy expansion.

The designation 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 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 review in SDP 2019, in which offshore wind farms have already been or will be built (in the "Helgoland cluster" N-4), are designated as reservation areas for wind energy. This means that the EN4 area has been "downgraded" from being a priority area for wind energy compared to the designations of the 2009 spatial plan.

Current findings from many years of wind farm monitoring are decisive for the designation as reservation areas. These findings have revealed significantly larger-scale avoidance effects and habitat losses for the wind farms located within the main concentration area of divers than had been assumed in the course of the approval and planning procedures.

ROP The sites to the north-west of shipping route 10 are shown as reservation areas. This means that they are not conclusively secured for wind energy in their respective extent, but are subject to weighing up of against other key interests for this use.

Compared with planning option C, where these sites were designated "future uses", this means a stronger weighting of the use for offshore wind energy. The designation at the level of spatial planning appears suitable for adequately taking the requirements of climate protection and marine nature conservation into consideration.

For areas EN9 to EN13, in which no wind turbines have been erected to date, the SEA for SDP 2019 leads to the conclusion that, based on the current status and the application of strict and effective preventative and mitigation measures, no significant environmental impacts are to be expected, at least at the level of sectoral planning.

For the areas beyond this, which would have to be used for an expansion to 40 GW, the draft spatial plan merely contains a reservation in order to be able to examine these in more detail in a later update of the FEP and to define them as specific areas, if the environmental assessment supports this.

Designating the areas now planned as reservation 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; in this time horizon, a development with wind energy parks in the sites designated as reservation areas is not necessary;

(b) A final balance is not possible because of 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 20 GW of installed capacity stipulated by law, but only for expansion beyond this, are designated as reservation areas for wind energy.
Presentation of the alternative compared with the draft plan	• The draft plan designates all areas likely to be required for the medium-term development of wind energy up to 2035 as priority areas (EN1 to EN3, EN6 to EN13), all other areas (E4, 5 and 14 to 19) as reservation areas.
Consequences for next planning levels	• FEP 2020 does not yet define sites for the areas EN11 to EN13. The preliminary examination of sites and the suitability assessment will only be carried out for those sites defined in the FEP. Thus, the designation as reservation areas has no direct consequences at the downstream level for the time being, but further designations in the course of an update of the FEP for wind energy expansion up until 2025 could not exclude the priority areas in the spatial plan. A partial update of the spatial plan for these areas could then become necessary.
Environmental assessment	• The designations of EN11 to EN13 as reservation areas mean the securing of offshore wind energy is still open to the extent that no final assessment has been made in favour of this use. This means that even more extensive environmental assessments will be required at a later date, for which it is expected that the knowledge from the procedures in the areas EN9 and EN10 that may already be available at that time can be used. • 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 the areas EN11 to EN13 as priority areas for wind energy.
Alternative 2: Wind Energy	
Brief description	• The areas of wind farms in the main distribution area of divers in areas EN4 and EN5 are not designated as reservation areas for wind energy.
Presentation of the alternative compared with the draft plan	• This would mean that in the long term, no areas for wind energy would be allowed in the reservation area for divers for a subsequent use of existing wind farms, while at the same time excluding the construction of installations outside the areas designated for this purpose.
Points of conflict with other uses	• Even if all other areas defined in the draft plan were to be used, this solution would probably lead to a situation where there would not be enough areas available in the German EEZ to achieve the long-term expansion target for wind energy of 40 GW.

Consequences for next planning levels	• In areas EN4 and EN5, no repowering permit would be granted after the expiry of the operating permits for the existing and approved wind farms and the dismantling of the installations.
Environmental assessment	• With regard to environmental impacts, the observed avoidance effects and habitat losses of divers could - in line with planning option C - be mitigated or compensated in the long term by the wind farm projects implemented in the main concentration area.

9.3.2.3 Lines

The reservation areas for cables and pipelines correspond to those which have already been presented in all three planning options in the planning concept. Only those corridors were defined in which at least two subsea cables and pipelines exist or are planned or which are reserved for future subsea cables and pipelines. These are required for the cable systems for diverting electricity from the areas for the generation of offshore wind energy based on the designations of the site development plan. The reservation areas secure the course of existing interconnectors and pipelines as well as routes for future cables and pipelines.

Nature conservation areas are as far as possible excluded from the designations, with the following exceptions:

- The routes of existing pipelines crossing the Dogger Bank nature conservation area,
- The route for the existing and planned connecting cables in the direction of the Ems corridor through the nature conservation area Borkum Riffgrund

By not designating corridors for individual lines, some existing or planned cable routes through nature conservation areas are not designated.

Compared with the planning concept, boundary corridors at the transition of the transmission lines into the territorial waters have been added similar to the designations of the ROP 2009 and based on the designations of the SDP.

The reservation areas for subsea cables and pipelines can be an instrument to demand, for example, in approval procedures for transit pipelines and cross-border submarine cables, that routing be used, where possible, in these corridors that is suitable for the overall area, and thereby avoid routing through nature conservation areas and the associated adverse effects. Where individual cables or other subsea cables and 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 a more nature-compatible routing as well as to the use of the defined corridors where possible.

Alternative: Lines	
Brief description	• Cable corridors for cable systems for conducting wind power generated in the EEZ are not routed through nature conservation areas but around them.
Presentation of the alternative compared with the draft plan	• This alternative would mean that the cable corridor, which runs through the Borkum Riffgrund nature conservation area in the draft plan, would either not be shown or would have to be laid completely around the conservation area.
Points of conflict with other uses	• This would be in conflict with the sectoral planning and the Lower Saxony spatial planning for the territorial sea, and with the cable systems already in place here and other cable systems required to conduct power generated in the EEZ towards the Ems corridor.
Consequences for next planning levels	• Future cable systems would have to be routed primarily in a corridor around the nature conservation area Borkum Reefground. This would lead the cable in the direction of the gate through which the Norpipe pipeline runs, and from there it would have to be routed in the territorial sea back to the Ems corridor. However, there is no option in the territorial sea for this which is secured from a spatial planning point of view.
Environmental assessment	• Although a - future diversion of cable routes around the nature conservation area would reduce the impact on the conservation area, the new routing and the significant increase in cable lengths would - apart from the lack of a basis for planning - be expected to result in loading additional pressure on the environment both in the EEZ and in the area of the territorial sea.

9.3.2.4 Raw material extraction

For the designations for raw material extraction in the North Sea EEZ, the draft includes the approach of planning option A - in addition to the assumptions on which all planning options are based:

Reservation areas for the extraction of hydrocarbons as well as for sand and gravel extraction are defined on the basis of planning option A, with an additional area added between the priority areas for wind energy EN1 and EN2. The Borkum Reefground nature conservation area was excluded from the sea area layout.

The area of the gas production platform A6/B4 at the outermost edge of the Duck's Bill will - in contrast to the three planning options - also be defined only as a reservation area for the extraction of raw materials and no longer as a priority area, because gas production has already ceased and the end of the current use of the platform for the processing of oil from Danish production is already foreseen.

There are large-scale permits for the exploration and production of gas in the south-western part of the EEZ and knowledge of deposits that are worth producing. The licences also cover the area of the nature conservation area Borkum Reefground. If, as in planning options B and C, no reservation areas for extraction are designated, the spatial planning authorities cannot refer to the principle which gives preference to a specific sub-area in the context of licensing procedures under mining law, and as such refer to sites for fixed exploration or production equipment outside the conservation area. Even if raw material extraction is not fundamentally ruled out in the nature conservation area, the fact that the spatial plan does not designate hydrocarbons within the protected area means that this use is less important and thus contributes to avoiding possible significant effects for the protected area and its protective purposes.

In the overlap area with reservation areas for offshore wind energy, synergy effects could be used with regard to area-efficient use for fixed infrastructure. KWN4 and 5 are located in the area of shipping routes SN3 and SN12. Here, locations in less frequented peripheral areas, possibly in close proximity to existing or planned neighbouring wind farm projects, would be preferred for fixed infrastructure.

The permit areas for sand and gravel extraction within the “Sylt Outer Reef” nature conservation area are designated as reservation areas analogous to planning options A and B. Here, the interaction with the designations of the priority area for divers and the priority area for nature conservation must be taken into consideration. The principle of avoiding mining from 1 March to 15 May is intended to protect the divers for which the area has an important function as a stopover 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 because 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 adverse effects for the protected assets and objectives.

Alternative: Raw material extraction	
Brief description	• The hydrocarbon exploration permits issued by the Mining Office are fully defined as reservation areas for the extraction of hydrocarbons (gas).
Presentation of the alternative compared with the draft plan	• The draft plan only includes individual sub-areas as reservation areas for raw material extraction. Overlaps with the nature conservation area Borkum Reefground are avoided, but there are spatial overlaps with areas for wind energy, shipping routes and cable/pipeline corridors.
Points of conflict with other uses	• The licence areas overlap in different ways with various uses and functions, with the nature conservation area Borkum Reefground, main shipping routes, cable/pipeline corridors.
Consequences for next planning levels	• The spatial planning authorities would not be in a position to work towards the adoption of preferred locations for fixed infrastructure for the exploration or production of hydrocarbons which are less conflicting with other interests of use and protection.
Environmental assessment	• The designation of a reservation area for the extraction of hydrocarbons, in particular in a nature conservation area, would give additional weight to this use in the context of spatial planning, despite the possible negative effects, inter alia through fixed infrastructure. In this respect, the omission of a designation for hydrocarbons within the conservation area, as envis-

	aged in the draft plan, contributes to avoiding possible significant effects on the conservation area and its protection purposes.

9.3.2.5 Fisheries

As regards fisheries, a new reservation area for fishing for Norwegian lobster (*Nephrops Norvegicus*) is established compared to the concept which did not include spatial designations.

Unlike for other target species and fishing, the occurrence and fishing effort for Norway lobster in the German EEZ can be relatively well determined and delimited ROP. The reservation area traces the current use and roughly covers the core area of the fishing effort*. Spatial control of Norwegian lobster cannot be achieved through the spatial plan. With the designation of the reservation area, fishing can be given special weight here in relation to competing uses.

Alternative designations for fishing were considered; however, due to a lack of current data on spatial allocation, no further areas were designated for spatial planning purposes.

9.3.2.6 Protection and improvement of the marine environment

With the spatial designations for protection and improvement of the marine environment in the North Sea EEZ, the nature conservation areas Sylt Outer Reef – Western German Bight, Borkum Reefground and Dogger Bank, which were established by ordinances, are also secured in spatial planning and their conservation objectives 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 impacts 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 harbour porpoise[13] as a reservation area, the latter being restricted to the months of May to August, which are particularly sensitive for the species. Thus, for the nature conservation areas, the planning approach from planning option C of the conception is taken up; the main concentration area of divers is identified as a priority area in the draft plan.

Sand and gravel extraction is still 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 help to ensure that the interests to be protected are taken into account in approvals and licences in addition to the requirements of the nature conservation area ordinances.

The priority area for divers also includes the existing wind farms in Areas EN4 and EN5. For any subsequent use of the areas, this supports a special consideration of the extent to which additional adverse effects on the habitat and significant cumulative impacts on the diver population are to be expected; the locations may therefore need to be reassessed. These areas are also presented in the spatial plan as being under consideration.

The EN13 area partly overlaps with the harbour porpoise reservation area. In the context of future procedures for the erection of wind turbines, requirements for suitable and effective measures for the avoidance and reduction of impulsive noise emissions should be supported (cf Chapter 10). This is to be ensured in particular during the sensitive period for harbour porpoises

[12] Position paper of the division of the Federal Ministry of the Environment on the cumulative assessment of the habitat loss of divers as a result of offshore wind farms (2009)

[13] Noise abatement concept of the Federal Environment Ministry (2013)

in order to provide them with sufficiently high-quality habitats at all times.

9.4 Justification for the choice of alternatives examined

The examination of reasonable alternatives at the spatial planning level compares conceptual/strategic planning options and spatial alternatives in the plan design.

The examination of reasonable alternatives 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 designations 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 designation 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 spatial scope of the spatial plan were always taken into consideration. At the same time, the identification and examination of the planning options or alternative plans to be considered can only relate to what can reasonably be required according to the content and level of detail of the spatial plan.

Alternative spatial designations have been considered for almost every use, whereby other locations are not always possible or practical within the limited dimensions of the EEZ. For example, raw material extraction 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 designations, especially if spatial alternatives were not considered as reasonable alternatives. In this way, the type of use in the areas was determined in such a way that the extent of the impacts is reduced. This environmental precaution applies to shipping as well as to economic and scientific uses. It includes the seasonal limitation of activities to protect sensitive bird species and marine mammals as well as the reference to mitigation measures and best environmental practice.

Since in many cases the spatial designation only traced the use and had little design scope for locating the use at this point, the search for an alternative design and consideration for the marine environment were an essential step for the examination of alternatives. This mitigates conflicts between protection needs and use claims and improves them in terms of environmental impact.

10 Measures planned to monitor the environmental impacts of implementing the site spatial plan

10.1 Introduction

According to No. 3 b) Annex 1 to Section 8, paragraph 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 measures.

With regard to the planned monitoring measures, it should be noted that the actual monitoring of the potential impacts on the marine environment can only begin when the spatial plan is implemented (i.e. when the designations made within the framework of the plan are implemented). Nevertheless, the natural development of the marine environment, including climate change, should not be disregarded when assessing the results of the monitoring measures. However, no general research can be conducted within the framework of monitoring. Therefore, project-related monitoring of the impacts of the uses regulated in the plan is of particular importance. This concerns mainly designations for offshore wind energy, lines, and areas for raw material extraction.

The essential task of monitoring the plan is to bring together and evaluate 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 address the unforeseen significant impacts of the implementation of the plan on the marine environment as well as the review of the projections of the environmental report.

In addition, results from existing national and international monitoring programmes must be taken into consideration – also to avoid duplication of work. The monitoring of the conservation status of certain species and habitats required under Article 11 of the Habitats Directive must also be taken into account, as well as the investigations to be carried out as part of the management plans for the nature conservation areas "Sylter Außenriff - Östliche Deutsche Bucht", "Borkum Riffgrund" and "Doggerbank", among others. It will also provide links with the measures provided in the MSFD.

10.2 The planned measures in detail

In summary, the planned measures for monitoring the potential impacts of the plan are as follows:

- Consolidation of data and information that can be used to describe and assess the status of areas and protected assets,
- Further development of existing expert information networks for the assessment of potential impacts from the development of individual projects as well as cumulative impacts on the marine ecosystem,
    - MarinEARS (Marine Explorer and Registry of Sound) and National Sound Register,
    - MARLIN (Marine Life Investigator),
- Development and/or use of procedures and criteria for evaluating the plan and adapting or, where appropriate, optimising it as part of the update,
- Evaluation of measures to avoid and mitigate significant impacts on the marine environment, taking into consideration possible cumulative effects.

The following data and information are required in order to assess the possible impacts of the plan:

1. Data and information available to the BSH within the scope of its responsibility:

- Data resources from previous EIS and monitoring of offshore projects that are available to the BSH for review (according to SeeAnlV),
- Data resources from the right of entry (according to WindSeeG),
- Data resources from the site investigations (according to WindSeeG),
- Data resources from monitoring the construction and operational monitoring of offshore wind farms and other uses
- Data from national monitoring collected by the BSH on behalf of the BSH,
- Data from research projects of the BSH.

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 activities as part of the implementation of the MSFD,
   - Data from the monitoring of Natura 2000 areas
   - Data provided by states from monitoring activities in the territorial waters,
   - Data from other authorities responsible for authorising offshore uses according to other legal bases, such as the Federal Mining Act, 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 carried out within the scope of international committees 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 carrying out the monitoring of the potential impacts of the plan, which focuses on the interdisciplinary pooling of marine environmental information. To be able to assess the causes of planned changes in parts or individual elements of an ecosystem, the anthropogenic variables from spatial observation (e.g. technical information on shipping traffic from AIS data resources) must also be considered and included in the assessment.

When consolidating and evaluating the results from monitoring at the project level and from other national and international monitoring programmes as well as from the accompanying research, a review of the knowledge gaps outlined in the environmental report or the forecasts subject to uncertainties will be carried out. This concerns, in particular, forecasts relating to the assessment of significant impacts on the marine environment of the uses regulated in the spatial plan. Cumulative effects of designated uses are to be assessed both regionally and supraregionally.

The investigation of the potential environmental impacts of areas for wind energy is to be carried out at the secondary project level, on the basis of 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 elements, measurements of underwater noise and acoustic recordings of the impact of pile driving on marine mammals using porpoise click detector (POD) instrumentation. 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 SDP 2019/SDP 2020.

The approval of areas for sand and gravel extraction, for example, must be verified by suitable monitoring before the next main operating plan approval to show that the maximum permitted extraction depth is not exceeded and that the original substrate is demonstrably preserved. It must also be demonstrated that sufficient non-extracted areas remain between the extraction tracks to ensure the potential for recolonisation.

For pipelines, a project-specific monitoring concept for the construction and operation phase must be submitted prior to construction. Monitoring measures during the construction phase include the documentation of turbidity plumes, hydro-acoustic measurements and the recording of marine mammals and sea and resting birds. The essential monitoring measures in 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 over a period of five years after commissioning.

New knowledge from the environmental impact studies and the joint evaluation of research and EIS data will be used as part of the strategic environmental assessment for the plan. Joint evaluation of research and EIS data also produces products that provide a better overview of the distribution of protected biological resources in the EEZ. The consolidation of information leads to an increasingly solid basis for impact forecasting.

The general 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 should be sought here. The geodata infrastructure already in place 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 consolidating and evaluating ecologically relevant data and will be further developed accordingly.

With regard to the consolidation and archiving of ecologically relevant data from the project-related monitoring and the accompanying research, the consolidation and long-term archiving of data collected in the context of accompanying ecological research in the BSH is envisaged. The BSH is already collecting and archiving the data on protected biological resources from the baseline surveys of offshore wind energy projects and the monitoring of construction and operating phases in the MARLIN (MarineLife Investigator), a specialist information network for environmental assessments.

11 Non-technical summary

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] . In accordance with Section 17, paragraph 1 ROG, the competent Federal Ministry, the Federal Ministry of the Interior, (BMI), shall draw up a spatial plan for the German EEZ as a statutory instrument in agreement with the federal ministries concerned. In accordance with Section 17, paragraph 1, sentence 3 ROG, the BSH, with the approval of the BMI, carries out the preparatory procedural steps for the preparation of the spatial plan. During the preparation of the ROP, an environmental assessment is carried out according to the provisions of the ROG and, where applicable, those of the Environmental Impact Assessment Act (UVPG)[15], the Strategic Environmental Assessment (SEA).

According to Article 1 of the SEA Directive 2001/42/EC, the objective 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 consideration in the preparation and adoption of plans well in advance of actual project planning.

The main content document of the Strategic Environmental Assessment is this Environmental Report. This identifies, describes, and assesses the likely significant impacts that the implementation of the ROP will have on the environment as well as possible and alternative planning options while taking the main purposes of the plan and the spatial scope into consideration.

According to Section 17, paragraph 1 ROG, the spatial plan for the German EEZ is to make designations taking into consideration any interrelationships between land and sea as well as safety aspects

1. for ensuring the safety and ease of movement of shipping traffic,
2. For further economical uses,
3. for scientific uses and
4. to protect and enhance the marine environment.

According to Section 7, paragraph 1 ROG, the spatial plan for a specific planning area and a regular medium-term period must contain designations as **objectives and principles** of spatial planning for the development, order, and safeguarding of the area, in particular for the uses and functions of the area.

According to Section 7, paragraph 3 ROG, these designations may also designate areas (e.g. priority and reservation 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. In this context, the instrument of maritime spatial planning is at the highest and superordinate level. The spatial plan is the forward-looking planning instrument that coordinates a wide variety of utilisation interests of economy, science, and research as well as protection claims. The SEA for the spatial plan is related to various downstream environmental assessments, in particular the directly downstream SEA for the site development plan (SDP).

The SDP is the sectoral planning for the orderly expansion of offshore wind energy. In the next

[14] Of 22 December 2008 (BGBl. I p. 2986, last amended by Article 159 of the ordinance of 19 June 2020 BGBl. I p. 1328).

[15] In the version of the announcement from 24 February 2010, BGBl. I p. 94, last amended by Article 2 of the Act of 30 November 2016 (BGBl. I p. 2749).

step, the sites for offshore wind turbines defined in the SDP are pre-examined. If the suitability of a site for the use of offshore wind energy is established, the site is put out to tender and the winning bidder can submit an application for approval for the construction and operation of wind turbines on the site. In view of the character of the spatial plan as a controlling planning instrument, the depth of the examination 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 consideration of alternatives.

The establishment or update of the spatial plan as well as the implementation of the SEA were carried out with due consideration for the objectives of environmental protection. These provide information on the environmental status to be aimed for in the future (environmental quality objectives). The objectives of environmental protection can be found in an overview of the international, EU and national conventions and regulations dealing with marine environment protection 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 site development plan and develops it further with a view to the additional designations made in the spatial plan.

The methodology is based primarily on the designations of the plan to be examined. Within the framework of this SEA, it is determined, described and evaluated for each of the designations whether the designations are likely to have significant impacts on the protected assets concerned. The subject matter of the environmental report corresponds to the designations of the spatial plan as listed in Section 17, paragraph 1 ROG. In particular, the impacts of the spatial designations are decisive here. Although textual objectives and principles without direct spatial designation often also serve to prevent and mitigate environmental impacts, they can, in turn, also lead to impacts; an assessment is thus required.

The assessment of the likely significant environmental impacts of the implementation of the spatial plan includes secondary, cumulative, synergistic, short-, medium- and long-term, permanent and temporary, positive and negative impacts in terms of the assets to be protected. The basis for the assessment of potential 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 assets:

- Site
- Seabed
- Water
- Plankton
- Biotopes
- Benthos
- Fish
- Marine mammals
- Avifauna
- Bats
- Biological diversity
- Air
- Climate
- Landscape
- Cultural assets and other material assets
- People, especially human health

- Interrelationships between protected assets

The description and assessment of the probable significant environmental impacts is carried out for the individual graphical and textual specifications on the use and protection of the EEZs in relation to the protected assets, taking into account the status assessment.

All plan contents that can potentially have significant environmental impacts are investigated. Both permanent and temporary (e.g. construction-related) impacts are considered. This is followed by a presentation of possible interrelationships as well as a consideration of possible cumulative effects and potential transboundary impacts.

An assessment of the impacts caused by the designations of the plan is carried out on the basis of the status description and status assessment and the function and significance of the respective areas designated for the individual protected assets on the one hand, and the impacts emanating from these specifications and the resulting potential impacts on the other. A forecast of the project-related impacts in the case of implementation of the spatial plan is made depending on the criteria of intensity, range, and duration of the effects.

Within the framework of the impact forecasting, specific framework parameters are used as a basis for assessment depending on the designations for the respective use.

With regard to the priority and reservation areas for offshore wind energy, certain parameters in the form of bandwidths are assumed for a consideration related to the protected assets. In detail, these are, for example, output per turbine, hub height, rotor diameter and total height of the turbines. Certain framework parameters are also assumed for lines, sand and gravel extraction, fishing, and marine research. In order to assess the environmental impacts of shipping, it is necessary to examine which additional impacts can be attributed to the designations in the spatial plan. The BSH has commissioned an expert report on the traffic analysis of shipping traffic for which up-to-date evaluations are expected.

11.3 Summary of protection-related audits

11.3.1 Site

The German EEZ in the North Sea and Baltic Sea is of high importance for many uses and for the marine environment. At the same time, their area is limited; land-saving use is thus imperative. Land economy is therefore also reflected in the guidelines and principles of the spatial plan.

The basis for a 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 result in the ROP for uses not always specifying the desirable area but rather the sufficient area.

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

Because of the following points, an assessment of the extent to which the designations of the ROP have impacts on the protected asset area is possible only 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 asset of land was carried out within the framework of the designations for the individual uses in the ROP itself.

11.3.2 Seabed

Sedimentology and morphology of the seabed in the German EEZ of the North Sea show regional differences; these can be well delineated by dividing them into four sub-areas (see also Chapter 2.2.2):

In the sub-area "Borkum and Norderneyer Riffgrund" (water depth: 18 to 42 m), the sediments are predominantly medium to coarse sand with ripple fields and occasional gravel and head-sized stones. Morphologically significant are the spurs of shoreface-connected ridges on the southern edge of the sub-area, which run in a northwest–southeast direction and are subject to pronounced sediment dynamics.

The sub-area "Northern Helgoland" (water depth: 9 to 50 m) is characterised by a very uneven relief for the conditions in the German Bight. Ice age ridges feature a characteristic covering of residual or relic sediments (coarse sand, gravel and stones). Between these residual sediment deposits there are thin fine to medium sands, which are subject to constant rearrangement. In comparison with the other sub-areas, a high density of stones can be observed on the seabed.

The seabed of the sub-area "Elbe glacial valley and western plains" (water depth: 30 to 50 m) has a very balanced relief and is largely flat. It consists of fine sands, some of which contain significant amounts of silt and clay. The defining element in the subsoil is the Elbe glacial valley on the eastern edge of the sub-area. 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 "Duck's Bill" comprises the sub-area "Dogger- und Nördliche Schillbank". The north-eastern spur of the Dogger Bank – a submarine ridge – crosses this area. The seabed largely lacks structure and consists mainly of a fine sand cover with significant silt and clay content. The seabed as a factor is mainly impaired offshore wind farms, raw material extraction, pipelines and fishing.

The installation of wind turbines, platforms, submarine cable systems and pipelines (including scour protection) create permanent but very small-scale sealing of the surface. Impacts during construction activities mainly include the formation of turbidity plumes and the sedimentation of 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 resuspended material. However, the current mining activities in the OAMIII permit field do not appear to have any significant adverse effects on the legally protected biotopes and the protected asset seabed.

A levelling of the seabed can also be observed in intensive fisheries, as can the formation of turbidity plumes near the bottom.

With the exception of two points (see below), the above impacts occur independently of the spatial plan and no significant negative impacts on the seabed as a factor are expected. Rather, adverse impacts can be avoided through the spatially coordinating designations of the ROP and through the specifications on the best environmental practice to be applied in each case.

With regard to wind energy, the designations of the ROP are associated with an expansion of the utilisation area, and the spatial designations in the ROP also assign a longer-term space requirement to raw material extraction. In both cases, given modern technology/extraction practices, no significant impacts on the seabed are expected.

11.3.3 Benthos and biotopes

The EEZ of the North Sea is not of outstanding importance with regard to the species inventory of benthic organisms. Nor do the benthic communities identified show any special features because they are typical of the EEZ of the North Sea because of the predominant sediments. Investigations of the macrozoobenthos in the context of the approval procedures for offshore wind farms and from AWI projects from 1997 to 2014 have revealed communities typical of the German North Sea. The species inventory found and the number of Red List species indicate an average importance of the area of investigation for benthic organisms.

The deep foundation of the wind turbines and platforms causes disturbance of the seabed, sediment turbulence, and the formation of turbidity plumes. The resuspension of sediment and the subsequent sedimentation can lead to an adverse effect or damage of the benthos and the use of biotopes in the immediate vicinity of the foundations for the duration of the construction activities. However, because of the prevailing sediment composition, these adverse effects will only have a small-scale effect and are limited in time. As a rule, the concentration of the suspended material decreases very quickly with removal. Depending on the given installations, changes in species composition may occur as a result of the local land sealing and the introduction of hard substrates in the immediate vicinity of the structures.

The laying of the submarine cable systems is also expected to cause only small-scale and short-term disturbances of the benthos and biotopes, through sediment resuspension and turbidity plumes in the area of the cable route. Possible impacts on the benthos and biotopes depend on the installation methods used. With the comparatively gentle cable laying using the flushing method, only minor disturbances in the area of the cable route are to be expected. Local sediment redistribution and turbidity plumes are to be expected during the laying of the submarine cable systems. Due to the predominant sediment composition in the North Sea EEZ, most of the sediment released will settle directly at the construction site or in its immediate vicinity. Benthic habitats are directly overbuilt in the area of necessary stone packing for cable crossings. The resulting habitat loss is permanent but small-scale. The result is a non-native hard substrate that can cause changes in species composition on a small scale.

Permanent habitat changes are limited to the immediate vicinity of foundations and stone packing, which are required in the case of cable laying on the seabed and cable crossings. stone packing permanently represents non-native hard substrate. This provides new habitats for benthic organisms and can lead to a change in the species composition. Significant impacts on benthos and biotopes are not expected from these small-scale areas. In addition, the risk of a negative impact on the benthic soft-bottom community by species untypical of the area is low because the recruitment of species is likely to occur from the natural hard-substrate habitats.

Because of operational conditions, a warming of the uppermost sediment layer of the seabed can occur directly above the cable system. With sufficient installation depth and taking into consideration the fact that the effects will be small-scale, no significant impacts on benthic communities are expected according to current state of knowledge. The ROP establishes a planning principle to minimise adverse effects as far as possible, and 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.

At the level of sectoral planning (SDP), the planning principle on sediment warming specifies that the 2 K criterion must be complied with. According to the assessment of the BfN, this precautionary value ensures with sufficient probability, based on current knowledge, that significant negative impacts of cable warming on the marine environment are avoided. As things stand at present, the planned submarine cable routes are not expected to have any significant impacts on benthos and biotopes provided the 2 K criterion is met. The ecological impacts are small-scale and mostly short-term.

With regard to the rules on the use of raw materials, long-term monitoring of the gravel sand area OAM III in the nature reserve Sylter Außenriff – Östliche Deutsche Bucht currently provides no indication that the extraction activities carried out to date have led to a fundamental change in the sediment structure or composition in the extraction area. Overall, the investigations show that the original substrate was preserved in the area and that there is a regenerative capacity, especially for species-rich gravel, coarse sand, and shingle seabeds*. On the basis of the monitoring carried out so far and in compliance with the ancillary provision of the main operating plan, it can therefore be assumed that significant impairment of benthic habitats and their communities can be ruled out with the necessary certainty by the rule for raw material use.

The proposed reservation area for Norway lobster fisheries has, for decades, been considered the traditional main area for Norway lobster *Nephrops norvegicus* with catches ranging from about 200 to 350 t per year. Increases in fishing effort because of the designation as a reservation area are not forecast. Thus, significant impacts on benthic communities and biotopes can be ruled out on the basis of the designations of the ROP on fishing. With regard to the general designation 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.

With regard to the uses of shipping, marine research, national and allied defence, and other uses, no significant impacts on benthos and biotopes are to be expected as a result of the designations of the ROP, which would go beyond the general effects of the uses without designation.

Designation of the nature conservation areas of the North Sea EEZ as nature conservation priority areas supports the positive effects on benthic communities and biotopes that can be expected on the basis of appropriate management measures for the nature conservation areas.

11.3.4 Fish

The fish fauna in the North Sea EEZ has a typical species composition. In all areas, the demersal fish community is dominated by flatfish, which is typical for the Deutsche Bucht. According to current state of 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 of no more ecological significance than adjacent marine areas. According to the current state of knowledge, the planned construction of wind farms and the associated converter platforms and submarine cable routes is not expected to have a significant adverse effect on the protected asset fish. The impacts of the construction of wind farms, converter platforms, and submarine cable systems on fish fauna is limited in space and time. During the construction phase of the foundations, the converter platforms and the laying of the submarine cable systems, the fish fauna may be temporarily adversely affected in small areas by sediment turbulence and the formation of turbidity plumes. Because of the prevailing sediment and current conditions, the turbidity of the water is expected to decrease again quickly. Based on the current state of knowledge, the adverse effects will therefore remain small-scale and temporary. Overall, small-scale adverse effects on adult fish can be expected to be minimal. In addition, the fish fauna is adapted to the natural sediment turbulence caused by storms that are typical here. Furthermore, during the construction phase, noise and vibrations may temporarily scare away fish. Noise from the construction phase shall be mitigated by appropriate measures. Further local impacts on fish fauna may result from the additionally introduced hard substrates as a result of a possible change in the benthos.

According to the current state of knowledge, the designation of priority areas for nature conservation may have a significant positive impact on fish fauna and counteract the overexploitation of some fish stocks in the North Sea.

According to the information available to date, the designations of other uses in the spatial plan such as raw material extraction, shipping, national and allied defence, or Norway lobster* fishing, does not result in any significant impacts on fish fauna that would exceed the general impacts of uses without designation.

With regard to the general designation 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 harbour porpoises cross and remain in the German EEZ and also use it as a food and area-specific breeding ground. Based on the knowledge available, it can be concluded that the EEZ is of medium to high importance for harbour porpoises in certain areas. Use varies in the sub-areas of the EEZ. This also applies to seals and grey seals*. Priority areas EN1 to EN3 are of medium to high importance for harbour porpoises (seasonally in spring) and low to medium importance for grey seals and harbour seals. Priority area EN4 is located in the main concentration area of harbour porpoises identified in the German Bight during the summer months and is therefore of high importance. Priority area EN4 is of medium importance for harbour seals and grey seals. Priority area EN5 is located in a large area used as both a feeding ground and a breeding site for harbour porpoises, although the main concentration area is situated within Area I of the “Sylt Outer Reef – Eastern German Bight” nature conservation area. In general, priority area EN5 for harbour porpoises is expected to be of high importance. Area EN5 is of medium importance for harbour seals and grey seals. Priority areas EN6 to EN12 are of medium importance for harbour porpoises. However, parts of priority areas EN11 and N13 are used intensively by harbour porpoises as a feeding ground in summer. They are located in the immediate vicinity of the contiguous main concentration area of harbour porpoise in the Deutsche Bucht and are therefore of great importance for harbour porpoises in the summer months. Priority areas EN6 to EN13 are of minor importance for harbour seals and grey seals. Priority areas EN14 to EN18 are of medium importance for harbour porpoises and low importance for harbour seals and grey seals. Reserved area EN19 is of medium importance for harbour porpoises and high importance seasonally, in the summer months. It is of minor importance for harbour seals and grey seals.

The plan identifies three priority areas for nature conservation: “Sylt Outer Reef – Eastern German Bight”, “Borkum Reef Ground” and “Dogger Bank”. The plan also specifies the main concentration area in the German EEZ that was identified during the preparation of the noise prevention concept for the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2013) as a priority area for the protection of harbour porpoises during the rearing season from 1 May to 31 August.

The spatial development plan identifies areas for wind energy production outside protected 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 reservation area for harbour porpoise in the German EEZ of the North Sea. The reservation area represents the main concentration area of the harbour porpoise during the sensitive period from 1 May to 31 August, which was identified during the development of the BMU noise abatement concept (2013). The seasonal reserve for harbour porpoises covers Area I of the "Sylt Outer Reef – Eastern German Bight" nature conservation area and its surroundings. From a physical point of view, the reservation area thus generously encompasses the area of the frontal system west of the North Frisian Islands. Weather and currents cause the frontal system to spread very dynamically into the protected area, ensuring increased productivity and a rich food supply for top predators such as harbour porpoises and many seabird species. By designating the seasonal reservation area, the spatial plan takes a preventive measure to safeguard the food-rich alternative habitat of the harbour porpoise outside Area I of the nature conservation area.

Threats to 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 abatement measures, significant adverse effects on marine mammals during pile driving could not be excluded. In the specific approval procedure, therefore, the driving of piles of offshore wind turbines and converter platforms will only be permitted if effective noise mitigation measures are used. To this end, the plan sets out principles and objectives.

These stipulate that the foundations must be installed using effective noise reduction measures so as to comply with applicable noise prevention specifications. In the specific approval procedure, extensive noise mitigation measures and monitoring measures are ordered to comply with applicable noise protection values (sound event level (SEL) of 160 dB re 1 µPa²s and maximum peak level of 190 dB re 1 µPa at a distance of 750 m around the pile driving or placement 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 impacts of noise on marine mammals. The BMUB noise abatement concept has also been in force since 2013. In accordance with the noise abatement 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 harbour porpoise in the summer months, are kept free of impacts caused by impact noise. Significant impacts on marine mammals from the operation of offshore wind turbines and converter platforms can be excluded according to the current state of knowledge.

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, no significant negative impacts on marine mammals are currently to be expected from the construction and operation of the planned offshore wind turbines and converter platforms. 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 allied 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 North Sea EEZ can be subdivided into various sub-areas, each of which has a seabird population to be expected in view of the prevailing hydrographic conditions, distances from the coast, existing prior pollution and species-specific habitat requirements.

The applications taken into account in the spatial development plan have various effects on seabirds and resting birds, most of which have a spatially and temporally limited impact on the area, or impact it for the duration of the activity. For species sensitive to disturbance, such as red-throated and black-throated divers, offshore wind farm projects have disturbing effects which – according to current scientific findings – lead to large-scale avoidance behaviour. There is no knowledge on habituation effects to date. For other species (e.g. guillemot), there are also findings on avoidance behaviour towards offshore wind farm projects, albeit to a lesser as well as seasonally and site-specifically varying, intensity than for divers.

The designation of areas EN4 and EN5 as reserved areas for offshore wind energy takes into account the review position of areas N-4 and N-5 for subsequent use for the protection of divers in SDP 2019. In addition, military use should interfere as little as possible with the conservation purpose of the diver priority area. From 1 March to 15 May of a given year, it applies that there should be no adverse effects from sand and gravel extraction in the priority area for divers and that the Federal Armed Forces authorities and the competent nature conservation authority should reach agreement on military use (cf ROP Principle (3) Chapter 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. The designation of the reservation areas for divers (StN1 to StN3) also takes account of the sustainable use of reservation areas EN4 and EN5.

Area EN13 takes into account a distance of 5.5 km from the main concentration area of divers in order to reduce potential additional habitat loss in the area. Excluding offshore wind energy in marine protected areas means that effects such as habitat loss in these important habitats will be reduced. The spatial plan also designates the “Sylt Outer Reef - Eastern German Bight” nature conservation area and the main concentration area for divers in the spring west off of Sylt as priority areas for nature conservation. Principles of the spatial development 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 allied 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 state of knowledge, the designations of the ROP for wind energy in areas EN1 to EN12 do not have any additional or significant impacts on the protected asset seabirds and resting birds. For the designations for the extended priority area EN13 and the conditional priority area EN13-North, this assessment can be made only in consideration of the overall plan assessment of the ROP (cf Chapter 7).

11.3.7 Migratory birds

The EEZ of the North Sea has an average to above-average importance for bird migration. Significant populations of songbirds breeding in northern Europe are thought to migrate across the North Sea. No specific migration corridors can be identified for any migratory bird species in the area of the EEZ of the North Sea because bird migration is either guideline-oriented and takes place close to the coast or in an unspecified broad-fronted migration across the North Sea. There are indications that migration intensity decreases with distance from the coast. However, this has not been clarified for the mass of songbirds migrating at night.

Possible impacts of offshore wind energy on migratory birds may be that they pose a barrier risk or risk of collision. Collision and barrier effects in important habitats are reduced by excluding wind energy in nature conservation areas. The other applications considered in the spatial development plan do not represent vertical barriers in the area.

According to the current state of knowledge, the spatial planning designations 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 knowledge merely confirms that bats, especially long-distance migratory species, fly over the North Sea.

Because of 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 adverse effects on bat migration over the EEZ of the North Sea. Other applications considered in the spatial development plan do not constitute comparable obstacles in the airspace.

According to the findings to date, the spatial designations of the spatial plan do not have any significant impacts on bats.

11.3.9 Air

The designations for wind energy in the ROP do not result in any measurable impacts on air quality. Impacts of shipping on air quality occur regardless of whether the ROP is implemented.

11.3.10 Climate

The CO_2 savings associated with the designations of offshore wind energy can be expected to have positive impacts on the climate in the long term.

11.3.11 Landscape

Impairment of the coastal landscape due to the planned wind farms in the German EEZ can be classified as minor. Through coordinated and harmonised overall planning, the designations of the ROP can minimise the space requirements for the expansion of offshore wind energy and thus – compared with the non-implementation of the plan – also reduce the impacts on the protected asset landscape.

For the subsea cables and pipelines, negative impacts on the landscape can be ruled out because of their installation in or on the seabed.

11.3.12 Cultural assets and other material assets

With further large-scale expansion of wind energy in the German EEZ, both known and previously undiscovered cultural assets and traces of settlement may be at greater risk of damage or destruction. However, this danger can be reduced through comprehensive coordination and agreement measures with the specialist authorities. At the same time, a considerable gain in knowledge can be expected for underwater archaeology with regard to underwater cultural assets and other cultural traces.

11.3.13 Biological diversity

Biological diversity comprises the diversity of habitats and biotic communities, the diversity of species, and the genetic diversity within species (Article 2 Convention on Biological Diversity, 1992). Biodiversity is in the public eye.

With regard to the current state of biodiversity in the North Sea, it should be noted that there is countless evidence of changes in biodiversity and species assemblages at all systematic and trophic levels in the North Sea. These are mainly because of human activities (e.g. fishing and marine pollution) or climate change. Red lists of endangered animal and plant species have an important monitoring and warning function in this context because they show the status of the populations of species and biotopes in a region. In the environmental report, possible impacts on biodiversity are dealt with under the individual protected assets. In summary, it can be said that, according to current knowledge, no significant impacts on biological diversity are to be expected from the Spatial Plan's provisions.

11.3.14 Interrelationships

In general, impacts on a protected asset lead to various consequences and interrelationships between the protected assets. The essential interconnection of the biotic protected assets exists via the food chains. Possible interactions during the construction phase result from sediment shifting and turbidity plumes, as well as noise emissions. However, these interactions occur only very briefly and are limited to a few days or weeks.

Installation-related interrelationships (e.g. through the introduction of hard substrate) are permanent but to be expected only locally. This could lead to a small-scale change in food supply.

Because of the variability of the habitat, interrelationships can only be described in a very imprecise manner overall. Basically, it can be stated that, according to the current state of knowledge, there are no discernible interrelationships that could result in a threat to the marine environment.

11.3.15 Cumulative effects

Seabed, benthos, and biotopes

A significant part of the environmental impacts of the areas for offshore wind energy and reservation areas for transmission lines on seabed, benthos, and biotopes will occur exclusively during the construction period (e.g. formation of turbidity plumes, sediment rearrangement) and in a spatially limited area. Because of the gradual implementation of the construction projects, construction-related cumulative environmental impacts are not very likely. Possible cumulative impacts on the seabed, which could also have a direct impact on the protected asset benthos and specially protected biotopes, result from the permanent direct area use of the foundations of the installations and from the cables* laid. The individual impacts are basically small-scale and local.

In the area where lines are laid, the adverse effect on sediment and benthic organisms will essentially be temporary. In the case of crossing particularly sensitive biotopes such as reefs or species-rich gravel, coarse sand, and fish grounds, permanent adverse effect would have to be assumed.

Please refer to the environmental report for the SDP 2019 and SDP 2020 for a balance of area use. There, an estimate of the direct area use by wind energy and power cables is made using model assumptions.

No statement can be made on the use of specially protected biotopes according to Section 30 BNatSchG because of the lack of a reliable scientific basis. 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 claim on the seabed and thus the habitat of the organisms settled there, plant foundations, overlying pipelines, and necessary crossing constructions lead to an additional supply of hard substrate. As a result, non-native hard substrate-loving species can colonise and change the species composition. This effect can lead to cumulative effects because of the construction of multiple offshore structures, piping or riprap in pipeline crossing areas. The hard substrate introduced also causes the loss of habitat for the benthic fauna adapted to soft bottoms. However, because both the grid infrastructure and the wind farms will result in an area use in the ‰ range, no significant adverse effects that would pose a threat to the marine environment in terms of the seabed and benthos are to be expected.

Fish

The impacts on fish fauna resulting from the designations are probably most strongly influenced by the realisation of an initial 20 GW of wind energy in the reservation areas of the North Sea and Baltic Sea. Here, the impacts of the OWFs focus on the regularly ordered closure of the area to fishing as well as the change in habitat and its interrelationship.

The anticipated fishery-free zones within the wind farm areas could have a positive impact on fish populations by eliminating negative fishing effects such as disturbance or destruction of the seabed as well as catch and by-catch of many species. Because of the lack of fishing pressure, the age structure of the fish fauna could develop again towards a more natural distribution so that the number of older individuals increases. The OWF could become an aggregation site for fish, although it has not yet been conclusively established whether wind farms attract fish.

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 growth of wind turbines with sessile invertebrates could favour benthophagous species and make a larger and more diverse food source accessible to fish (Glarou et al. 2020). 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 impacts to the population level of fish.

Species composition could also change directly, as species with habitat preferences different from those of established species – such as reef dwellers – find more favourable living conditions and occur more frequently. In the Danish wind farm Horns Rev, 7 years after its construction, a horizontal gradient in the occurrence of hartsubrate-affected species was found between the surrounding sand areas and near the turbine foundations: Clifffish, eel mother and lumpfish were found much more frequently near the wind turbine foundations than on the surrounding sand areas (LEONHARD et al. 2011). Cumulative effects resulting from a major expansion of offshore wind energy could include

- an increase in the number of older individuals,
- better conditions for the fish because of a larger and more diverse food base,
- further establishment and distribution of fish species adapted to reef structures
- he 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 (also referred to as density limitation). It cannot be ruled out that local density limitation sets in within individual wind farms 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. The impacts of changes in fish fauna on other elements of the food web – both below and above their trophic level – cannot be predicted given the current state of knowledge.

Together with the designations 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 effects on marine mammals, in particular harbour porpoises, may occur mainly due to noise exposure during the installation of deep foundations. For example, marine mammals can be significantly affected by the fact that – if pile driving is carried out simultaneously at different locations within the EEZ – there is not enough equivalent habitat available to avoid and retreat to.

The realisation of offshore wind farms and platforms to date has been relatively slow and gradual. Between 2009 and 2018, pile driving work took place at twenty wind farms and eight converter platforms in the German North Sea EEZ. Since 2011, all pile driving work 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 mitigation 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 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 4 was it necessary to coordinate the pile driving work, including the deterrence measures.

The evaluation of the noise results with regard to noise propagation and the possibly resulting accumulation has shown that the propagation of impulsive noise is strongly limited when effective noise-minimising measures are applied (BRANDT et al. 2018, DÄHNE et al., 2017).

Cumulative impacts of the plan on the population of harbour porpoise are considered in accordance with the requirements of the noise abatement concept of the BMU of 2013. In order to avoid and mitigate cumulative impacts on the harbour porpoise population in the German EEZ, the orders of the downstream approval procedure shall specify a restriction of the sound exposure of habitats to maximum permitted proportions of the EEZ and nature conservation areas. According to this, the propagation of noise emissions may not exceed defined areas of the German EEZ and nature conservation areas. This ensures that sufficient high-quality habitats are available for the animals to escape at all times. The arrangement primarily serves to protect marine habitats by preventing and minimising disturbances caused by impulsive sound input.

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 sensitive period of the harbour porpoise 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 "Sylter Außenriff – Östliche Deutsche Bucht" 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.

Defining the protected area for harbour porpoises means that the standards for the protection of impulsive noise emissions applicable to projects in the "Sylt Outer Reef – Eastern German Bight" protected area will also apply in future to projects in and around the protected area as part of subordinate approval procedures.

The area reserved for harbour porpoises during the summer months includes the "Sylt Outer Reef" protected area and its immediate surroundings. Pile driving operations with the potential to cause disturbance due to noise in the main concentration area of harbour porpoises during the sensitive season are coordinated in such a way that the proportion of the area affected remains below 1% at all times. In accordance with the noise abatement concept of the BMU (2013), all pile driving activities are coordinated with the objective of always keeping sufficient escape routes free in the protected areas, in equivalent habitats, and in the entire German EEZ.

As a result, it is concluded that implementation of the plan will result in 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 need to be assessed on a species-specific basis. In particular, species of Appendix I of the Birds Directive, species of sub-area II of the "Sylter Außenriff – Östliche Deutsche Bucht" nature conservation area, and such species for which an avoidance behaviour towards structures has already been determined are to be considered with regard to cumulative impacts.

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

The main concentration area takes into consideration the period that is particularly important for the species: the spring. The main concentration area was designated in 2009 on the basis of the data available at the time: the main concentration area was home to around 66% of the German North Sea diver (diver) population and around 83% of the EEZ population in spring, and is therefore, among other things, of particular importance in terms of population biology (BMU 2009) and an important functional component of the marine environment with regard to seabirds and resting birds. Against the background of current stock assessments, the importance of the main concentration area for divers in the German North Sea and within the EEZ has further increased (SCHWEMMER et al. 2019). The delineation of the main concentration area of divers is based on the data basis, which is considered to be very good, and on expert analyses that find broad scientific acceptance. The area includes all areas of very high and most of the areas of high sea otter density in the "Deutsche Bucht". The designation of the main concentration area of divers in the German EEZ of the North Sea as part of the position paper of the BMU (2009) is an important measure to ensure species protection of the sturgeon-sensitive species red-throated and black-throated diver. The BMU decreed that in future approval procedures for offshore wind farms, the main concentration area should be used as a benchmark for the cumulative assessment of diver habitat loss.

The current results from the operational monitoring of offshore wind farms and from research projects, some of which used investigation methods independent of the standardised monitoring in accordance with Standard Investigation Concept (StUK) (e.g. telemetry study within the framework of the DIVER project), unanimously 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 from an FTZ study were presented at the BSH's Marine Environment 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 compared with 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). The statistically significant decrease in abundance is not due to total avoidance but rather to partial avoidance with increasing densities of divers up to a distance of 10 km from a wind farm. The calculated total habitat loss of 5.5 km is used to quantify the habitat loss in analogy to the former shooing distance of 2 km. It is based on the purely statistical assumption that there are no divers within 5.5 km of an offshore wind farm. A further cross-project study on the occurrence and distribution of as well as effects of offshore wind farm projects on divers in the German North Sea commissioned by the BWO provided comparable results for all implemented wind farm projects, with a significant avoided distance of 10 km and a calculated total habitat loss of approx. 5 km. 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 and research projects consistently show that the avoidance behaviour of divers towards offshore wind farms is far more pronounced than previously assumed. A stock calculation for the main concentration area within the scope of the sea diver study of the FTZ commissioned by BfN and BSH showed an increase in the red-throated diver population for the period from 2002 to 2012, which has remained at a relatively constant high level since 2012. However, for the entire German North Sea, the sub-areas of which are of varying local importance as habitats for divers, a decrease in the population of red-throated divers has been observed since 2012 (observation period until 2017) (SCHWEMMER et al. 2019). The study commissioned by the BWO yields qualitatively and quantitatively comparable stock figures and stock trends for the main concentration area and the German North Sea. Differences can be attributed to different methodologies for stock calculation as well as modified data bases.

Both studies confirm the overall high and special functional importance of the main concentration area as a habitat for divers in the German North Sea (SCHWEMMER et al. 2019, BIOCONSULT SH et al. 2020). This is especially true against the background of the pronounced avoidance behaviour and the accompanying habitat loss.

The main concentration area is a particularly important component of the marine environment with regard to seabirds and resting birds, especially the species group divers. The spatial planning definition of the main concentration area of divers as a reserved area, according to which the planning, construction and operation of energy generation plants in the main diver concentration area should not take place if this leads to significant impairment of the diver habitat, specifically takes into account the protection of divers in this particularly important habitat, especially given the avoidance behaviour observed from the operating phase of the OWFs in the North Sea EEZ. The designation of Areas EN4 and EN5 within the main concentration area as reservation areas for offshore wind energy takes up the review of Areas N-4 and N-5 for subsequent use in the SDP 2019 (BSH 2019) and SDP 2020 (BSH 2020a) at the spatial planning level. In addition, military use should interfere as little as possible with the conservation purpose of the diver priority area. From 1 March to 15 May of a given year, it applies that there should be no adverse effects from sand and gravel extraction in the priority area for divers and that the Federal Armed Forces authorities and the competent nature conservation authority should reach agreement on military use (cf ROP Principle (3) Chapter 2.4 Nature conservation). This gives additional consideration to the protection of the diver species group, which is sensitive to disturbance and its particularly important habitat in the EEZ of the North Sea. The designation of the reservation areas for divers (StN1 to StN3) simultaneously takes account of the sustainable use of reservation 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 installations applied for.

The definitions of other applications are located outside the main diver concentration area, in areas of lesser importance for divers, and/or that refer to applications where impact is mostly temporary and local (see corresponding sections in Chapters 3 and 4).

For other species of seabirds and resting birds, it can be assumed that the designations 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 because they exclude uses that are incompatible with nature conservation. These definitions protect important habitats and reduce habitat impairment and collision risks there. Outside the nature conservation areas, the occurrence of some species is large-scale 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 sub-chapters in chapters 3 and 4). In addition, some spatial planning designations (e.g. on shipping) are not expected to lead to a densification or increased intensity of use but rather represent replications of existing levels of activity.

As a result of the SEA, significant cumulative impacts of the spatial planning designations on the protected asset seabirds and resting birds are not to be expected according to the current state of knowledge. For the designations on the extended priority area EN13 and the conditional priority area EN13-North in relation to the main concentration area, this assessment can be made only in consideration of the overall plan assessment of the ROP (cf Chapter 7).

Migratory birds

Barrier effects and collision risks in important food and resting habitats are reduced by defining priority and reserved areas for offshore wind energy in a spatial context and excluding offshore wind energy in protected areas. The impacts of the other uses or their designations 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 designations of all considered uses on migratory birds can be excluded with the necessary certainty.

11.3.16 Cross-border impacts

The SEA concludes that, as things stand at present, the designations of the ROP do not have significant impacts on the areas of neighbouring countries bordering the German EEZ of the North Sea.

Significant cross-border impacts can generally be ruled out for the following protected assets: seabed, water, plankton, benthos, biotopes, landscape, cultural heritage, and other material assets and the protected asset human beings and human health.

With regard to the protected asset fish, the SEA comes to the conclusion that, according to the current state of knowledge, no significant cross-border impacts on the protected asset are to be expected as a result of the implementation of the ROP because, on one hand, the areas for which the ROP makes designations do not have a prominent function for the fish fauna. On the other hand, the recognisable and predictable effects are of a small-scale and temporary nature.

Based on the current state of knowledge and taking into consideration impact-minimising and damage-limiting measures, significant cross-border impacts can also be ruled out for the protected asset marine mammals. For example, the installation of the foundations of wind turbines and converter platforms is only permitted in the specific approval procedure if effective noise mitigation measures are implemented.

For the protected asset seabirds and resting birds, the Danish bird conservation area "Sydlige Nordsø" which directly borders the German EEZ to the north and also has a high seabird population, must be taken into consideration when considering possible significant transboundary impacts. Based on current knowledge, the spatial development plan is not expected to have any significant effects as a result of the definitions.

For migratory birds, erected wind turbines in particular can represent a barrier or a risk of collision. By defining areas for wind energy exclusively outside marine protected areas, these effects are reduced in important resting areas for some migratory bird species. The other applications taken into account in the spatial development plan have no comparable spatial effects. According to the current state of knowledge, no significant transboundary impacts on migratory birds are to be expected from the designations in the spatial plan.

11.4 Species protection law assessment

Whether the plan meets the wildlife conservation requirements of Section 44, paragraph 1, No. 1 and No. 2 BNatSchG for specially and strictly protected animal species is examined in the context of the study on assessment of wildlife conservation regulations. In particular, it is examined whether the plan violates species protection prohibitions.

In accordance with Section 44, Paragraph 1, No. 1 BNatSchG, killing or injuring wild animals of specially protected species, (i.e. animals listed in Appendix IV of the Habitats Directive and Appendix I of the V-RL Birds Directive is prohibited. The species protection assessment in accordance with Section 44, paragraph 1, No. 1 BNatSchG always refers to the killing and injury of individuals.

In accordance with Section 44, paragraph 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.

<u>Protected marine mammals</u>

The update of the plan contains principles according to which the input of sound into the marine environment during the construction of installations is to be avoided according to 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 specification with regard to individual work steps such as deterrence measures as well as a slow increase in pile driving energy by means of "soft-start" procedures within the framework of the subordinate procedures, the site development plan, the suitability assessment of sites and, in particular, within the framework of the respective planning approval as well as within the framework of enforcement. By means of deterrence measures and the "soft-start", it can be ensured 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 range of measures avoids the species protection concerns of Article 44(1) no. 1 of the Federal Nature Conservation Act with sufficient certainty.

According to the current state of knowledge, neither the operation of the installations nor the laying and operation of the wind farm's internal submarine cabling will have any significant negative impacts on marine mammals that meet the killing and injury criteria under Article 44 subsection (1) number 1 of the Federal Nature Conservation Act.

The temporary implementation of the pile driving work is not expected to cause significant disturbance to harbour porpoises within the meaning of Section 44, paragraph 1, No. 2 BNatSchG.

According to the current state of knowledge, it is not to be assumed that disturbances that may occur because of 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 are in 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 mitigated. However, this must be investigated 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 mitigation systems in the sense of the principles and objectives in the update of the plan as well as subsequent orders in the planning approval of the BSH and consideration for 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 specifying orders that ensure effective noise abatement management through appropriate measures.

- Preparation of a sound prognosis taking into consideration the location- and installation-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 specified soundproofing concept adapted to the selected foundation structures and erection processes for the implementation 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 noise mitigation 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 noise abatement 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 noise mitigating measures,
- operating noise-mitigating insallation design according to the state of the art.

In order to avoid cumulative impacts caused by parallel pile driving work on different projects, a temporal coordination of pile driving work is ordered within the framework of subordinate planning approval procedures and enforcement in accordance with the specifications of the noise abatement concept of the BMU (2013). The noise abatement concept of the BMU (2013) pursues a site-based approach with the objective of always maintaining sufficient high-quality alternative habitats for the harbour porpoise population in the German EEZ of the North Sea free of disturbance-triggering noise inputs.

As a result, if the aforementioned strict noise protection and noise mitigation measures are applied in accordance with the principles and objectives of the plan and the orders in the planning approval decisions, taking into consideration the noise abatement concept of the BMU (2013) and compliance with the limit value of 160 dB SEL_5 at a distance of 750 m, significant disturbances within the meaning of Section 44, paragraph 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 in accordance with Section 44, Paragraph 1, No. 2 BNatSchG.

Spatial planning and the designations of the plan, including the principles and objectives, are among the central instruments for mitigating or even preventing cumulative impacts on the harbour porpoise population through the equalisation of spatial conflicts between uses and the designation of priority and reservation 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 within the framework of individual approval procedures.

In addition, the 2013 noise prevention concept for the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety for the North Sea includes a number of requirements, through the habitat approach pursued, which ensure effective prevention and reduction of cumulative effects on the local harbour porpoise population in the German EEZ and the populations in the nature conservation areas due to impact noise. This plan has designated the main concentration area of harbour porpoises in the German North Sea EEZ that was identified, during the preparation of the noise prevention concept for the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2013), as the protected area for harbour porpoises during the sensitive period from 1 May to 31 August. The special requirements of the noise prevention concept for the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety are arranged in the nature conservation areas and the protected area as part of the subordinate procedures or individual approval procedures for applications.

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 Section 44, paragraph 1, No. 1 and No. 2 BNatSchG also with regard to cumulative impacts.

Cumulative view

In Chapter 4.11.3, cumulative effects of offshore wind energy production on harbour porpoises were presented and avoidance and mitigation measures were described. However, the harbour porpoise is exposed to the impacts of various anthropogenic uses as well as natural and climate-induced changes. A differentiation or even weighting of the proportion of impacts by a single 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 within the framework of individual approval procedures.

Spatial planning and the designations of the plan, including the principles and objectives, are among the central instruments for mitigating or even preventing cumulative impacts on the harbour porpoise population through the equalisation of spatial conflicts between uses and the designation of priority and reservation areas for nature conservation.

<u>Protected seabird species</u>

In accordance with Section 44, paragraph 1, No. 1 BNatSchG in conjunction with Article 5 V-RL*, it is prohibited to hunt, capture, injure, or kill wild animals of specially protected species. Specially protected species include the species listed in Annex I of the Birds Directive, species whose habitats and habitats are protected in nature conservation areas and in the area reserved for divers, as well as characteristic species of the areas to which the plan relates. Accordingly, injuring or killing resting birds as a result of collisions with wind turbines must be ruled out in principle. 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, a collision of divers is not to be expected because of their pronounced avoidance behaviour towards vertical obstacles.

However, the measures ordered (e.g. 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 operating phase so as to facilitate an improved nature conservation assessment of the actual risk of bird strikes at the turbines. Moreover, the right to arrange further measures is expressly reserved on regular occasions. Against this background, the BSH does not believe that there is a significant increase in the risk of killing or injuring migratory birds.

It can therefore not be assumed that the prohibition of injury and killing of Section 44, paragraph 1, No. 1 BNatSchG is realised.

As a result, the SEA assessments for SDP 2019 and SDP 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 impacts as a result of the avoidance behaviour are intense and permanent.

In order to prevent a deterioration of the conservation status of the local population because of 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 SDP 2019 and SDP 2020.

Finally, for offshore wind farms in Areas EN1 to EN12, as well as EN14 to EN19, it is not assumed, according to the current state of knowledge, that the disturbance requirement according to Section 44, paragraph 1, No. 2 BNatSchG is fulfilled. For the designations for the extended priority area EN13 and the conditional priority area EN13-North, this assessment can be made only in consideration of 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 scaring effects in 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 1 January 2030. Therefore, the extent to which avoidance and mitigation measures must be applied to the specific installations applied for must be examined in the individual procedure.

Cumulative impacts

Seabirds are exposed to the effects of various anthropogenic applications and natural and climate-related changes. A differentiation or even weighting of the share of the impacts 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 the qualitative assessment of cumulative effects on divers within the framework of approval procedures of offshore windparks using the main concentration area in accordance with the BMU position paper (2009). The cumulative consideration of the avoidance behaviour of divers towards offshore wind farms within the framework of studies commissioned by the BSH and the BfN revealed 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). The statistically significant decrease in abundance is not due to total avoidance but rather to partial avoidance with increasing densities of divers up to a distance of 10 km from a wind farm.

Planning of wind power generation outside protected 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 site development plan and the site investigation and examination of the suitability of sites 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 within the framework of individual approval procedures.

The policy paper of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2009) on the protection of divers provides the basis for assessment of the cumulative effects of wind energy generation. The designation of the main concentration area as a priority area for the protection of divers is the most important avoidance and mitigation measure to exclude cumulative impacts at the population level. The reserved area represents a protected area for the strictly protected and also the characteristic seabird species of the German EEZ in the North Sea in addition to the three nature reserves due to its special location in the area of the frontal system to the west of the North Frisian Islands, with its very high productivity and the resulting rich food supply.

Finally, for offshore wind farms in Areas EN1 to EN12, as well as EN14 to EN19, it is not assumed, according to the current state of knowledge, that the disturbance requirement according to Section 44, paragraph 1, No. 2 BNatSchG is fulfilled. For the designations for the extended priority area EN13 and the conditional priority area EN13-North, this assessment can be made only in consideration of the overall plan assessment of the ROP (cf Chapter 7).

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 knowledge merely confirms 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 according to

Section 44, paragraph 1, No. 1 BNatSchG nor the species protection prohibition of significant disturbance in accordance with Section 44, paragraph 1, No. 2 BNatSchG are to be expected.

11.5 Impact assessment

Insofar as an area of Community importance or a European bird conservation area may be significantly adversely affected in its components relevant to the conservation objectives or the protective purpose, according to Section 7, Paragraph 6 in conjunction with Paragraph 7 ROG, the provisions of the Federal Nature Conservation Act on the admissibility and implementation of such interventions, including obtaining the statement of the European Commission, shall be applied when amending and supplementing 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 remote 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 preventative 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 adverse effect on the conservation objectives of the Natura2000 areas or 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 consideration that for some uses – especially wind energy – the ROP traces the projects already in operation and the designations of the SDP sectoral planning for which impact assessments have already been carried out.

Before being designated as marine areas pursuant to Article 20(2) 57 of the Federal Nature Conservation Act under European law, the nature conservation areas in the EEZ had been included as FFH sites in the first updated list of sites of Community importance in the Atlantic biogeographical region pursuant to Article 4(2) of the Habitats Directive (Official Journal of the EU, 15 January 2008, L 12/1), so an FFH impact assessment had already been performed as part of the Federal Offshore Sectoral Plan for the German North Sea EEZ (BSH 2017). Most recently, an impact assessment pursuant to Article 34 para(1) in conjunction with Article 36 of the Federal Nature Conservation Act was carried out as part of the SEA for the site development plan (BSH, 2019).

The German EEZ of the North Sea contains the nature conservation areas “Sylt Outer Reef – Eastern German Bight” (Regulation on the establishment of the nature conservation area “Sylt Outer Reef – Eastern German Bight” of 22 September 2017), “Borkum Reef Ground” (Regulation on the establishment of the nature conservation area “Borkum Reef Ground” of 22 September 2017) and “Dogger Bank” (Regulation on the establishment of the nature conservation area “Dogger Bank” of 22 September 2017).

The total area covered by the three nature conservation areas in the German North Sea EEZ is 7,920 km^2, of which 625 km^2 is covered by the “Borkum Reef Ground” nature conservation area, 5,603 km^2 by the “Sylt Outer Reef – Eastern German Bight” nature conservation area and 1,692 km^2 by the “Dogger Bank” nature conservation area.

Within the framework of the impact assessment, the habitat types “reef” (EU code 1170) and “sandbank” (EU code 1110) according to Appendix I of the Habitats Directive with their characteristic and endangered biotic communities and species as well as protected species, specifically fish (river lamprey, twaite shad), marine mammals according to Appendix II of the Habitats Directive (harbour porpoise, grey seal, and harbour seal) as well as protected bird species according to Appendix I of the Birds Directive (in particular red-throated diver, black-throated diver, little gull, Sandwich tern, common tern, and Arctic tern) and regularly occurring migratory bird species (in particular common and lesser black-backed gull, northern fulmar, northern gannet, kittiwake, guillemot, and razorbill) are to be observed.

The impact assessment also takes into consideration the remote effects of the designations adopted within the EEZ on the protected areas in the adjacent 12-mile zone and in the adjacent waters of neighbouring countries.

Construction, installation and operational effects on the FFH habitat types "Reef" and "Sandbank" with their characteristic and endangered biocoenoses and species can be excluded due to the exclusion by technical legislation of areas and sites for wind energy in the SDP in nature conservation areas. The areas lie far outside the drift distances discussed in the literature so that no release of turbidity, nutrients, and pollutants that could adversely affect the nature conservation and FFH areas in their components relevant to the conservation objectives or the conservation purpose is to be expected.

Whether the designations lead to adverse effects on habitat types must be assessed prognostically, taking into consideration project-specific effects.

For the sections of the 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 in accordance with Lambrecht & Trautner (2007) and Bernotat (2013) are not exceeded.

With regard to remote effects, the impact assessment of the plan with regard to the strictly protected species harbour porpoise has shown that, according to the current state of knowledge, a significant adverse effect of the conservation objectives of the nature conservation areas can be ruled out with the necessary certainty by implementing the ordered noise abatement measures.

The ROP also provides for the designation of a reservation area for harbour porpoise in the German EEZ of the North Sea. The reservation area represents the main concentration area of the harbour porpoise during the sensitive period from 1 May to 31 August, which was identified during the development of the BMU noise abatement concept (2013). The seasonal reserve for harbour porpoises covers Area I of the "Sylt Outer Reef – Eastern German Bight" nature conservation area and its surroundings. From a physical point of view, the reservation area thus generously encompasses the area of the frontal system west of the North Frisian Islands. Weather and currents cause the frontal system to spread very dynamically into the protected area, ensuring increased productivity and a rich food supply for top predators such as harbour porpoises and many seabird species. By designating the seasonal reservation area, the spatial plan takes a preventive measure to safeguard the food-rich alternative habitat of the harbour porpoise outside Area I of the nature conservation area.

To protect the divers , various measures have already been defined within the framework of the SDP. Besides the preventive measure implemented by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2009), restricting offshore wind energy within the main concentration area for divers, exclusion of the "Butendiek" offshore wind farm for possible subsequent use is another important mitigation measure. Finally, the requirement to examine the possible subsequent use of areas EN4 and EN5 within the framework of the site development plan constituted a further monitoring measure.

The update of the ROP also provides for the designation of a priority area for the diver in the German EEZ of the North Sea. The priority area represents the main concentration area of divers during spring in the German EEZ; this was identified during the preparation of the position paper of the BMU (2009). The priority area comprises Area II of the nature conservation area "Sylter Außenriff – Östliche Deutsche Bucht" and its surroundings. From a physical point of view, the priority area thus generously encompasses the area of the frontal system west of the North Frisian Islands. Because of weather and currents, the frontal system spreads very dynamically into the priority area and ensures increased productivity and a rich food supply for top predators such as divers but also many other species of seabirds. By designating the reservation area, the spatial plan takes a preventive measure to safeguard the food-rich alternative habitat of the diver outside Area II of the nature conservation area.

Taking into account the above-mentioned measures ensuring the protection of divers both inside and outside the nature conservation area "Sylt Outer Reef – Eastern German Bight", significant impairment of the conservation objectives can be ruled out with the necessary certainty.

11.6 Measures to avoid, mitigate, and compensate for significant negative impacts of the site development plan on the marine environment

In accordance with No. 2 c) Annex 1 to Section 8, paragraph 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 impacts resulting from the implementation of the plan.

In principle, the ROP takes better consideration of the concerns of the marine environment. The designations of the ROP will prevent 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 expand offshore wind energy and the corresponding connecting cables exists in any case, and the corresponding infrastructure would have to be created even without a ROP (cf Chapter 3.2). However, in the event of non-implementation of the plan, the uses would develop without the space-saving and resource-conserving steering and coordination effect of the ROP.

Moreover, the designations of the ROP are subject to a continuous optimisation process because the knowledge obtained on a rolling basis within the framework of the SEA and the consultation process is taken into consideration when the plan is compiled.

While individual avoidance, mitigation, and compensatory measures can be implemented at the planning level, others come into effect only during concrete implementation and are regulated there in the individual planning approval on a project- and site-specific basis.

With regard to planning preventative and mitigation measures, the ROP defines spatial and textual designations that, according to the environmental protection objectives set out in Chapter 1.4, serve to prevent or mitigate significant negative impacts of the implementation of the ROP on the marine environment. This concerns, among other things, spatial designations of 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 mitigation in the construction of wind turbines, and the principle of taking best environmental practices in accordance with the OSPAR Convention and the respective state of the art in science and technology in economic and scientific uses into consideration.

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 lines, the aim should be to achieve the greatest possible bundling in the sense of routing them parallel to each other. In addition, the routing should be chosen parallel to existing structures and installations as far as possible.

In addition to the aforementioned measures at the plan level, there are measures for the avoidance and reduction of insignificant and significant negative impacts in the actual implementation of the ROP for certain designations or associated uses such as offshore wind energy, subsea cables and pipelines, and sand and gravel extraction. These mitigation and avoidance measures are specified and ordered by the respective competent licensing authority at the project level for the planning, construction, and operation phases.

11.7 Examination of reasonable alternatives

In accordance with Article 5, paragraph 1, sentence 1 SEA Directive in conjunction with the criteria in Appendix I SEA Directive and Section 40, paragraph 2, No. 8 UVPG, the environmental report contains a brief description of the reasons for the choice of the reasonable alternatives examined within the framework of the preparation of the draft spatial plan. At the planning level, it is primarily the conceptual/strategic design and spatial alternatives that play a role.

In principle, it should be noted that a preliminary examination of possible and conceivable planning options is already inherent in all designations 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 designation 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 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 basis for the planning solutions to be investigated and the examination of alternatives is provided by the mission statement and the planning guidelines (Section1 of the Spatial Plan). Whereas initially three overall plan alternatives were examined within the framework of the preparation of the planning concept on the basis of selected environmental aspects, in particular individual area specifications, further (partial) spatial alternatives or different spatial planning areas (such as priority areas, reservation areas) were considered and environmentally assessed for the preparation of the 1st draft plan. Area designations for wind energy in the outer EEZ are made 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 spatial plan because requirements and spatial demands have changed considerably since the ROP 2009 came into force and the need for more far-reaching designations has become clear, particularly with respect to nature conservation. The draft plan is expected to lead to a comparatively lower overall area use and thus to lower environmental impacts because of more comprehensive overarching and forward-looking planning and coordination while taking a large number of spatial claims into consideration (cf Chapter 3).

The planning solution to be preferred from an environmental point of view was not always included in the draft plan. Rather, the overall context of the plan had to be considered. In the choice of plan solutions, in addition to the consideration of nature conservation concerns and the prevention or reduction of possible negative environmental impacts, a balance with the 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 designations made in the spatial plan according to the current state of knowledge.

11.8 Measures planned to monitor the environmental impacts of implementing the site spatial plan

According to No. 3 b) Annex 1 to Section 8, paragraph 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 measures.

The monitoring also serves to verify the gaps in knowledge and the forecasts with uncertainties as presented in the environmental report. In accordance with Section 45, paragraph 4 UVPG, the results of the monitoring are to be taken into consideration in the update of the ROP.

The actual monitoring of potential impacts on the marine environment can begin only once the uses regulated under the plan have been realised. The project-related monitoring of the impacts of offshore wind farms, lines, and raw material extraction is therefore particularly important. The main task of monitoring is to bring together and evaluate the knowledge from the various monitoring results at the project level. In addition, existing national and international monitoring programmes should be taken into consideration – also to avoid duplication of work.

The investigation of the potential environmental impacts of areas for wind energy is to be carried out at the secondary project level, on the basis of the standard “Investigation of impacts of offshore wind turbines (StUK4)” and in coordination 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 SDP 2019/SDP 2020.

For the approval of areas for sand and gravel extraction, for example, a verification must be provided by suitable monitoring before the next main operating plan approval that the maximum permitted extraction depth is not exceeded, the original substrate is preserved, and sufficient non-extracted areas remain so that the recolonisation potential is given.

For pipelines, monitoring measures during the construction phase include the documentation of turbidity plumes, hydro-sound measurements, and the survey of marine mammals as well as seabirds and resting birds. The essential monitoring measures in 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 carrying out a whole series 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 for cost reduction in the collection of monitoring data for offshore wind farms” and the R&D study BeMo “Assessment approaches for underwater noise monitoring in connection with offshore licensing procedures, spatial planning and MSFD” as well as various sub-projects within the framework of the R&D network NavES “Nature-compatible offshore developments”. The results of the current projects of the BSH will be directly incorporated into the further development of standards and norms, such as the development of the StUK5.

The consolidation 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 update of the SDP.

11.9 Evaluation of the overall plan

In summary, with regard to the designations of the spatial plan, it applies that through the orderly, coordinated overall planning, the impacts on the marine environment shall be minimised as far as possible. The safeguarding of the nature conservation areas designated by ordinance as priority areas for nature conservation maintains protective purposes and safeguards open space. The designation of the main concentration area of divers, which is larger in terms of area, as a priority area encompassing Sub-area II of the nature conservation area “Sylter Außenriff – Östliche Deutsche Bucht” may also have a positive impact on other species protected in the nature conservation area or bird conservation area 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 EEZ of the North Sea. Because other uses (military use, sand and gravel extraction) are to have as few adverse effects as possible on the protective purpose of the priority area for divers and because there is to be no interference by sand and gravel extraction or agreement on military use from 1 March to 15 May of any given year, the protection of divers is additionally emphasised.

In addition, by excluding installations above the water surface*, designation 2.4 (5) serves to implement measures to secure the coherence of the Natura 2000 network (coherence measures) with regard to adverse effects emanating from existing wind turbines in the priority or reservation area for divers. In order to enable nature conservation sectoral planning to develop its own compensatory regulation in this respect, the temporary designation 2.4 (5) is made as spatial planning support; through this, the area in question is temporarily protected from conflicting uses. This also supports the protection of divers.

However, according to the current state of knowledge, it must be assumed that the wind farm projects to be realised on EN13 will have scaring effects on the priority area divers to the extent identified and that an individual examination must be performed in order to determine the extent of avoidance and mitigation measures for the installations in the application process. However, overall, the positive effects outweigh the negative impacts because of the designation of the main concentration area as a priority area for divers beyond the protected area “Sylter Außenriff – Östliche Deutsche Bucht” established by ordinance and because of the aforementioned designations on the consideration of conservation purposes. The designation of the reservation areas for divers (StN1 to StN3) simultaneously takes account of the sustainable use of reservation areas EN4 and EN5.

The reservation areas for lines run predominantly outside of ecologically significant areas. If stricter preventative and mitigation measures are complied with, significant impacts can be avoided, especially 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 interrelationships, that, according to current state of knowledge and at the comparatively abstract level of spatial planning, no significant impacts on the marine environment within the area of investigation are to be expected as a result of the planned designations.

Based on the same medium-term time horizon, most of the environmental impacts of the individual uses for which designations are made would also arise if the plan were not implemented. This is because it is not apparent 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 designations of the plan appear basically “neutral” with regard to their impacts on the environment. Although it is possible in principle that, because of the concentration/bundling of individual uses on certain areas/territories, some plan specifications may well have negative environmental impacts in the area of this specific area, an overall balance of the environmental impacts would tend to be seen as positive because of the bundling effects because the remaining sites/areas are relieved and treats to the marine environment (e.g. risk of collision) are reduced.

No detailed data or findings are available for individual protected assets for certain specifications in the area north of shipping route SN10. For this reason, the SEA forecasts for these specifications require more detailed assessment in the context of subordinate planning stages.

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