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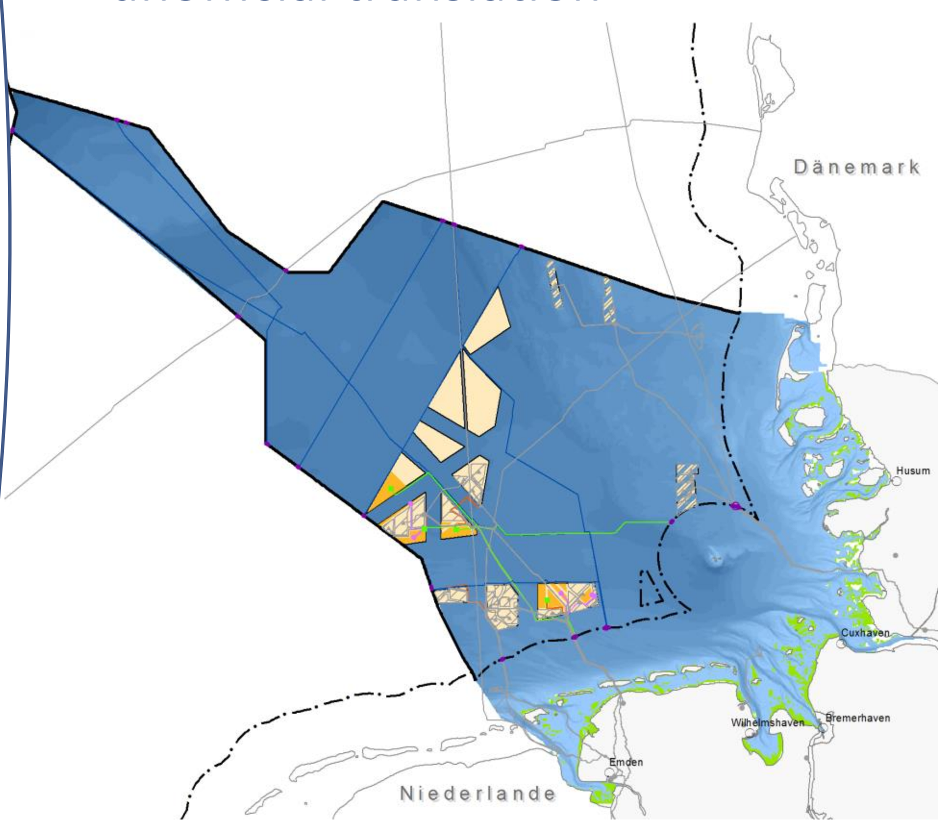
Environmental Report
for the Site Development Plan 2019
for the German North Sea

- unofficial translation -



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Content

1 Introduction 1

1.1 Legal basis and tasks of the environmental assessment 1

1.2 Brief description of the content and most important objectives of the Site Development Plan 1

1.3 Tiered planning procedures – relationship to other relevant plans, programmes and projects (environmental assessment at the appropriate planning level) 3

1.3.1 Introduction 3

1.3.2 Maritime spatial planning (EEZ) 6

1.3.3 Site Development Plan 7

1.3.4 Site investigation 9

1.3.5 Approval procedure (planning approval and planning permission procedure) for offshore wind turbines 10

1.3.6 Approval procedure for grid connections (converter platforms and submarine cable systems) 11

1.3.7 Interconnectors 12

1.3.8 Summary overviews of environmental assessments 12

1.4 Presentation and consideration of environmental protection objectives 19

1.4.1 International conventions on the protection of the marine environment 19

1.4.2 Environmental and nature conservation requirements at EU level 23

1.4.3 Environmental and nature conservation requirements at national level 26

1.4.4 The Federal Government's energy and climate conservation aims 28

1.5 Strategic Environmental Assessment methodology 30

1.5.1 Introduction 30

1.5.2 Area of investigation 31

1.5.3 Carrying out the environmental assessment 32

1.5.4 Criteria for status description and assessment 35

1.5.5 Specific assumptions for assessment of likely significant environmental effects 39

1.5.6 Fundamentals of the assessment of alternatives 44

1.6 Data sources and indications of difficulties in compiling the documents 45

1.6.1 Overview of data source 46

1.6.2 Indications of difficulties in compiling the documents 46

2 Description and assessment of state of the environment 49

2.1 Introduction 49

2.2 Soil/Area 49

2.2.1 Protected asset Land 49

2.2.2 Data availability 49

2.2.3 Geomorphology 50

2.2.4 Sediment distribution on the seabed 50

2.2.5 Geological structure of the near-surface subsoil 52

2.2.6 Distribution of pollutants in the sediment 53

2.2.7 Status estimation 55

2.3 Water 57

2.3.1 Currents 57

2.3.2 Swell 58

2.3.3 Temperature, salinity and seasonal stratification 58

2.3.4 Ice conditions 60

2.3.5 Fronts 60

2.3.6 Suspended matter and turbidity 61

2.3.7 Status assessment with regard to nutrient and pollutant distribution 61

2.4 Plankton 64

2.4.1 Data availability 64

2.4.2 Spatial distribution and temporal variability of phytoplankton 65

2.4.3 Spatial distribution and temporal variability of zooplankton 66

2.4.4 Status assessment of plankton 68

2.5 Biotopes 70

2.5.1 Data availability 70

2.5.2 Legally protected marine biotopes according to section 30 of the Federal Nature Conservation Act and FFH habitat types 73

2.5.3 Status estimation 75

2.6	Benthos	77
2.6.1	Data availability	77
2.6.2	Spatial distribution and temporal variability	79
2.6.3	Status assessment of the factor Benthos	88
2.7	Fish	92
2.7.1	Data availability	94
2.7.2	Spatial distribution and temporal variability	95
2.7.3	Status assessment of the factor Fish	98
2.8	Marine mammals	107
2.8.1	Data availability	108
2.8.2	Spatial distribution and temporal variability	109
2.8.3	Status assessment of the factor Marine mammals	115
2.9	Seabirds and resting birds	120
2.9.1	Data availability	120
2.9.2	Spatial distribution and temporal variability	120
2.9.3	Status assessment of seabirds and resting birds	131
2.10	Migratory birds	135
2.10.1	Data availability	135
2.10.2	Spatial distribution and temporal variability of migratory birds	136
2.10.3	Status assessment of the factor Migratory birds	141
2.11	Bats and bat migration	145
2.11.1	Data availability	145
2.11.2	Spatial distribution and status assessment	146
2.12	Biodiversity	147
2.13	Air	148
2.14	Climate	148
2.15	Scenery	148
2.16	Cultural heritage and other material assets	149
2.17	Human beings, including human health	149
2.18	Interrelationships between the factors	149
3	**Likely evolution without implementation of the plan**	**152**
3.1	Soil/Area	153

3.2	Water	154
3.3	Plankton	155
3.4	Biotopes	155
3.5	Benthos	155
3.6	Fish	156
3.7	Marine mammals	156
3.8	Seabirds and resting birds	157
3.9	Migratory birds	157
3.10	Bats and bat migration	158
3.11	Biodiversity	158
3.12	Air	159
3.13	Climate	159
3.14	Scenery	159
3.15	Cultural heritage and other material assets	160
3.16	Human beings, including human health	160
3.17	Interrelationships between the factors	160
4	**Description and assessment of the likely significant effects of the implementation of the Site Development Plan on the marine environment**	**161**
4.1	Soil/Area	162
4.1.1	Areas, sites and platforms	162
4.1.2	Submarine cabling systems	163
4.2	Benthos	165
4.2.1	Areas and sites	165
4.2.2	Platforms	167
4.2.3	Submarine cabling systems	167
4.3	Biotopes	170
4.3.1	Areas and sites	170
4.3.2	Platforms	170
4.3.3	Submarine cabling systems	171
4.4	Fish	171
4.4.1	Areas and sites	172

4.4.2 Platforms 173
4.4.3 Submarine cabling systems 175
4.5 Marine mammals 176
4.5.1 Areas and sites 176
4.5.2 Platforms 179
4.5.3 Submarine cabling systems 180
4.6 Seabirds and resting birds 181
4.6.1 Areas and sites 181
4.6.2 Platforms 184
4.6.3 Submarine cabling systems 184
4.7 Migratory birds 185
4.7.1 Areas and sites 186
4.7.2 Platforms 188
4.7.3 Submarine cabling systems 189
4.8 Bats and bat migration 189
4.8.1 Areas and sites 189
4.8.2 Platforms 189
4.8.3 Submarine cabling systems 189
4.9 Climate 190
4.10 Landscape 190
4.10.1 Areas and sites 190
4.10.2 Platforms 190
4.11 Interdependency 191
4.12 Cumulative effects 192
4.12.1 Soil/area, benthos and biotopes 193
4.12.2 Fish 194
4.12.3 Marine mammals 195
4.12.4 Seabirds and resting birds 195
4.12.5 Migratory birds 199
4.13 Transboundary impacts 200
5 Assessment of wildlife conservation regulations 202
5.1 Marine mammals 202

5.1.1 Section 44 subsection 1 no. 1 of the Federal Nature Conservation Act (prohibition of injury and killing) 203

5.1.2 Section 44 subsection 1 no. 2 of the Federal Nature Conservation Act (prohibition of disturbance) 205

5.2 Avifauna (seabirds, resting birds and migratory birds) 211

5.2.1 Section 44 subsection 1 no. 1 of the Federal Nature Conservation Act (prohibition of injury and killing) 212

5.2.2 Section 44 subsection 1 no. 2 of the Federal Nature Conservation Act (prohibition of disturbance) 213

5.3 Bats 229

5.3.1 Section 44 subsection 1 no. 1 and no. 2 of the Federal Nature Conservation Act 229

6 Assessment of the implications 231

6.1 Legal basis 231

6.2 Impact assessment of the Site Development Plan with respect to the habitat types 232

6.2.1 Impact assessment of the conservation objective of the "Borkum Reef Ground" nature conservation area 233

6.2.2 Impact assessment with the conservation objective of the nature conservation area "Sylt Outer Reef – Eastern German Bight" 234

6.2.3 Impact assessment of the conservation objective of the "Dogger Bank" nature conservation area 238

6.3 Impact assessment of the Site Development Plan for protected species 238

6.3.1 Assessment of the implications pursuant to section 34 subsection 1 of the Federal Nature Conservation Act in connection with Art. 6 (3) of the Habitats Directive and in accordance with section 5 subsection 6 of the Ordinance on the Establishment of the Nature Conservation Area "Borkum Reef Ground" 238

6.3.2 Assessment of the implications pursuant to section 34 subsection 1 of the Federal Nature Conservation Act in connection with Art. 6 (3) of the Habitats Directive and in accordance with section 5 subsection 6 of the Ordinance on the Establishment of the Nature Reserve "Sylt Outer Reef – Eastern German Bight" with regard to marine mammals and protected bird species 241

6.3.3 Impact assessment pursuant to section 34 subsection 1 of the Federal Nature Conservation Act in conjunction with Art. 6 (3) of the Habitats Directive and in accordance with section 5 subsection 7 of the Ordinance on the Establishment of the Nature Conservation Area "Dogger Bank" 249

6.4 Natura 2000 areas outside the German EEZs 251

6.5 Results of the assessment of the implications 253

7 Overall plan evaluation 254

8 Measures to prevent, mitigate and offset significant negative effects of the Site Development Plan on the marine environment 255

8.1 Introduction 255

8.2 Areas and sites for offshore wind turbines 256

8.3 Platforms 257

8.4 Submarine cable systems (DC and AC Subsea Cable Systems) 259

9 Investigated alternatives 260

9.1 Zero alternative 260

9.2 Strategic alternatives 261

9.3 Spatial alternatives 261

9.3.1 Examination of alternatives for areas 262

9.3.2 Comparison of the sites with one another 263

9.3.3 Alternative routes for gates N-IV and N-V 267

9.3.4 Bypass sandbank Borkum reef ground 268

9.3.5 Other alternatives assessed 270

9.4 Technical alternatives 270

10 Measures envisaged for monitoring the environmental impacts 273

10.1 Monitoring of the potential effects of the areas and sites for offshore wind turbines 275

10.2 Monitoring of potential effects of platforms 276

10.3 Monitoring of the potential effects of submarine cables 276

11 Non-technical summary 278

12 References 297

List of figures

Abbildung 1: Übersicht zum gestuften Planungs- und Zulassungsprozess im zentralen Modell 4

Abbildung 2: Übersicht zu den Schutzgütern in den Umweltprüfungen 6

Abbildung 3: Umweltprüfungen im gestuften Planungs- und Zulassungsprozess mit dem Fokus der jeweiligen Prüfung.. 13

Abbildung 4: Gegenstand der Planungs- und Zulassungsverfahren mit Schwerpunkten in der Umweltprüfung.. 14

Abbildung 5: Übersicht zu Schwerpunkten in den Umweltprüfungen im Planungs- und Zulassungsverfahren 17

Abbildung 6: Übersicht zu den Normebenen der einschlägigen Rechtsakte für die SUP............... 30

Abbildung 7: Darstellung des Untersuchungsraums der SUP für die Nordsee zum Flächenentwicklungsplan. 32

Abbildung 8: Allgemeine Methodik der Bewertung der voraussichtlichen erheblichen Umweltauswirkungen. 34

Abbildung 9: Sedimentverteilung in der AWZ (Laurer et al. 2014). Die Klassifikation erfolgt nach Figge (1981). Quelle: http://www.gpdn.de.. 52

Abbildung 10: Vektormittel der Strömung in der oberflächennahen Schicht (Messtiefe 3 bis 12 m). Die Messpositionen sind mit einem roten Punkt markiert (BSH 2002).. 58

Abbildung 11: Jahresmittel der Nordsee-Oberflächentemperatur für die Jahre 1969-2017........... 59

Abbildung 12: Mittlere Schwebstoffverteilung (SPM) für die deutsche Nordsee. 61

Abbildung 13: Verteilungsmuster der löslichen anorganischen Stickstoffverbindungen (DIN). 62

Abbildung 14: Räumliche Verteilung der Mesozooplankton-Gemeinschaften laut Clusteranalyse auf der Basis der Abundanzen aller Taxa und deren Entwicklungsstadien in der deutschen AWZ 2010 (Wasmund et al. 2011).. 68

Abbildung 15: Karte der auf Grundlage vorhandener Daten abgrenzbaren Biotoptypen der deutschen Nordsee. 72

Abbildung 16: Naturräumliche Einteilung der deutschen AWZ der Nordsee nach Rachor & Nehmer (2003), Schlussbericht für BfN. 80

Abbildung 17: Anzahl Arten (oben) und Abundanz (unten) von benthischen Arten der Roten Liste im bereich der deutschen AWZ (aus Dannheim et al. 2016)... 84

Abbildung 18: Siedlungsgebiete der wichtigsten Bodentier-Lebensgemeinschaften (Makrozoobenthos, nach Bodengreiferproben) in der deutschen AWZ der Nordsee und angrenzenden Gebieten (aus Rachor & Nehmer 2003, Schlussbericht für BfN); im Bereich des Küstenmeeres ist die Darstellung unvollständig. 85

Abbildung 19: Ermittelte großskalige Gemeinschaften und regionale Geo-Cluster basierend auf Abundanzen der Epifauna in der deutschen AWZ der Nordsee (nach Dannheim et al. 2014a). SW-W DB = westliche Südwestliche-Deutsche Bucht, SW-O DB = östliche Südwestliche-Deutsche

Bucht, N EUT = Nördliches Elbeurstromtal, S EUT = Südliches Elbeurstromtal, NW DB I = Nordwestliche Deutsche Bucht I, NW DB II = Nordwestliche Deutsche Bucht II. 86

Abbildung 20: Ermittelte großskalige Gemeinschaften und regionale Geo-Cluster basierend auf Abundanzen der Infauna in der deutschen AWZ der Nordsee (nach DANNHEIM et al. 2014a). Cluster: ZN = Zentrale Nordsee, Af = Amphiura filiformis Gemeinschaft, Nn = Nucula nitidosa Gemeinschaft, Nn.fl = flache Nucula nitidosa Gemeinschaft, Mb = Macoma balthica Gemeinschaft, FS.Z = Feinsand zentral, DBG.Tf = Doggerbank/Tellina fabula Gemeinschaft, MIX = heterogene Sande, MS.SAR = Mittelsand Sylter Außenriff, MS.EUT = Mittelsand Elbe Urstromtal, MS.W = Mittelsand West, MGS.BRG = Mittel-Grobsand Borkum Riffgrund, GS.MS = Grobsand-Mittelsand, GS = Goniadella/Spisula Mittel-Grobsand, none = nicht definiert. Geo-Cluster: SW-W DB = westliche Südwestliche-Deutsche Bucht, OF/NF Küste = Ostfriesische/Nordfriesische Küste, NW DB I, II = Nordwestliche Deutsche Bucht I, II. 87

Abbildung 21: Relative Ähnlichkeit der Artenzusammensetzung und der artspezifischen Abundanzen bodenlebender Fische in der deutschen AWZ der Nordsee. Die zentrale Gemeinschaft (ZG, blaue Punkte), die Küstengemeinschaft (KG, grüne Punkte) und zwei Gemeinschaften des Entschnabels (ES I & II, gelbe und orange Punkte) können klar voneinander angegrenzt werden. Gebiete mit weniger als sechs Stationen wurden keiner Fischgemeinschaft zugewiesen (graue Symbole e, g, h, b und d). Nicht-metrische multidimensionale Skalierung basierend auf √-transformierten und aufwandsnormierten Abundanzdaten aus Fängen mit einer 2-m-Baumkurre (RACHOR & NEHMER (2000) und BENDER (2014); N = 173 Stationen). Aus DANNHEIM et al. (2014). 96

Abbildung 22: Karte zur räumlichen Variabilität der ermittelten Fischgemeinschaften der deutschen AWZ der Nordsee basierend auf aufwandskorrigierten Abundanzdaten. Abkürzungen, Analysemethoden, Farbcodierungen und Stichprobengröße wie in Abbildung 21. Aus DANNHEIM et al. (2014). 97

Abbildung 23: Box-Whisker-Plots der (a) Abundanz (Individuen * km^{-2}) und (b) Biomasse (kg * km^{-2}) der ermittelten Fischgemeinschaften in der deutschen AWZ der Nordsee. Abkürzungen, Analysenmethoden und Stichprobengrößen wie in Abbildung 21. Aus DANNHEIM et al. (2014). 97

Abbildung 24: Oben: R-Werte für die Unterschiedlichkeit der OWF-Gebiete (einfaktorielle ANOSIM) basierend auf Abundanzdaten der demersalen Fische. Die R-Werte entsprechen dem mittleren R-Wert der einzelnen paarweisen Tests zwischen den OWF-Gebieten. Oben: Unterschiede zwischen den ermittelten Geo-Clustern in verschiedenen Farben. Unten: Karte der OWF-Gebiete (Zahlen) und Lage der aus den R-Werten (einfaktorielle ANOSIM) ermittelten Geo-Cluster (Farben, siehe Karten-Legende). SW-W DB: westliche Südwestliche-Deutsche Bucht, SW-O: östliche Südwestliche-Deutsche Bucht, N EUT: Nördliches Elbeurstromtal, S EUT: Südliches Elbeurstromtal, NW DB: Nordwestliche Deutsche Bucht. Aus DANNHEIM et al. (2014). 100

Abbildung 25: Relative Anteile der Rote-Liste-Kategorien an den Fischarten, die in den Gebieten 1-3, 4, 5, 6-8 und 9-13 nachgewiesen wurden. Ausgestorben oder verschollen (0), vom Aussterben bedroht (1), stark gefährdet (2), gefährdet (3), Gefährdung unbekannten Ausmaßes (G), extrem selten (R), Vorwarnliste (V), Daten unzureichend (D) oder ungefährdet (*) (Thiel et al. 2013). (UVS-Daten ab 2014 für Cluster 1-8 und Daten von 2017/2018 aus der DATRAS-Datenbank des ICES, s. 2.8.1). Zum Vergleich sind die relativen Anteile der Bewertungskategorien der Rote Liste Nordsee (Thiel et al. 2013) dargestellt. 102

Abbildung 26: Gesamtartenliste Fische Deutsche AWZ Nordsee und Artnachweise in den Gebieten 1-3, 4, 5, 6-8 und 9-13 (UVS-Daten ab 2014 für Gebiete 1-8 und Daten von 2017/2018 aus der DATRAS-Datenbank des ICES). 104

Abbildung 27: Zusammenfassung des Status der Fischbestände in der Nordsee 2017. Links: Die Fischereiintensität gibt die Anzahl der Bestände (oben) und den Biomasseanteil am Fang (unten; in 1000 Tonnen) an, der unterhalb (grün) oder oberhalb (rot) des Referenzwerts (fischereiliche Intensität für den nachhaltigen Dauerertrag, FMSY) liegt. Rechts: Die Reproduktionskapazität gibt die Anzahl der Bestände (oben) und den Biomasseanteil am Fang (unten) an, der oberhalb (grün) oder unterhalb (rot) des Referenzwertes (Laicherbiomasse, MSY Btrigger) liegt. Grau gibt die Anzahl bzw. den Biomasseanteil am Fang von Beständen an, für die keine Referenzpunkte definiert sind und für die folglich keine Bestandseinschätzung möglich ist. Insgesamt wurden 118 Bestände betrachtet, die zusammen 4.518.000 Tonnen Fang lieferten. Verändert nach ICES (2017c). 106

Abbildung 28: Rasterdarstellung der Verteilung von Schweinswalen in der deutschen Nordsee und Sichtungen von Mutter-Kalb-Paaren (GILLES, unveröff., zitiert in BMU, 2013). 118

Abbildung 29: Vorkommen von Seetauchern in der Deutschen Bucht – Befliegung von 14. / 15.04.2011 (MARKONES & GARTHE 2011, Monitoringbericht 2010/ 2011 im Auftrag des BfN). 124

Abbildung 30: Vorkommen von Sturmmöwen in der deutschen Nordsee - Befliegung vom 04., 12. & 13.03.2014 (MARKONES et al., 2015, Monitoringbericht 2014 im Auftrag des BfN). 125

Abbildung 31: Vorkommen von Trottellummen und unbestimmten Individuen der Artengruppe Trottellumme/Tordalk in der deutschen Nordsee - Befliegung 01. & 29.09.2014 (MARKONES et al., 2015, Monitoringbericht 2014 im Auftrag des BfN). Der Anteil der Tordalken an der unbestimmten Artgruppe ist mit großer Sicherheit zu dieser Jahreszeit als gering einzustufen (siehe Erläuterungen zur Verbreitung des Tordalk). 126

Abbildung 32: Schema zu Hauptzugwegen über der südöstlichen Nordsee (dargestellt für den Herbst aus HÜPPOP et al. 2005a) 139

Abbildung 33: Relative Anteile der ermittelten Flugrichtungen bei der Forschungsplattform FINO1 im Herbst, für vier Tageszeiten und für den ganzen Tag (grau) gemittelt über die Jahre 2005 bis 2007. Die Summe der einzelnen Richtungsanteile innerhalb einer Kreisgrafik ergibt jeweils 100%. Die Pfeilrichtung in der Kreismitte kennzeichnet die mittlere Flugrichtung, die Pfeillänge ist ein Maß für deren Eindeutigkeit (HÜPPOP et al. 2009). 139

Abbildung 34: Anteile der Artengruppen an allen Ruferfassungen in der Nähe der Forschungsplattform FINO1 vom 12.3.2004 bis zum 1.6.2007 (HÜPPOP et al. 2012). 141

Abbildung 35: Trassenalternativen zu Grenzkorridor N-IV bzw. N-V. 268

List of tables

Tabelle 1: Vorhabenbezogene Auswirkungen bei Umsetzung des FEP. 39

Tabelle 2: Parameter für die Betrachtung der Gebiete und Flächen 42

Tabelle 3: Parameter für die Betrachtung der Netzanschlüsse und Umspann-/Wohnplattformen .. 43

Tabelle 4: Parameter für die Betrachtung der Seekabelsysteme 43

Tabelle 5: Zustandseinschätzung des Schutzgutes „Boden“ im Hinblick auf Sedimentologie und Geomorphologie im Untersuchungsgebiet. 55

Tabelle 6: Mittlere Strömungsgeschwindigkeiten, Rest- und Gezeitenströme in der Deutschen Bucht. 57

Tabelle 7: Naturräumliche Einheiten der deutschen AWZ der Nordsee und in den FEP-Gebieten (nach RACHOR & NEHMER 2003).. 81

Tabelle 8: Bestände der wichtigsten Rastvogelarten in der deutschen Nordsee und der AWZ in den vorkommensstärksten Jahreszeiten nach MENDEL et al. (2008). Frühjahrsbestände der Sterntaucher nach SCHWEMMER et al. (2019), Frühjahrsbestände der Prachttaucher nach GARTHE et al. (2015)... 121

Tabelle 9: Zuordnung in die Gefährdungskategorien der Europäischen Rote Liste der wichtigsten Rastvogelarten der deutschen AWZ in der Nordsee. Definition nach IUCN: LC = Least Concern, nicht gefährdet; NT = Near Threatened, Potentiell gefährdet; VU = Vulnerable, Gefährdet; EN = Endangered, Stark gefährdet; CR = Critically Endangered, vom Aussterben bedroht. 133

Tabelle 10: Mittlere Zugintensität (Ind/h) über See in den ersten drei Stunden nach Sonnenaufgang für alle Arten zusammen an den drei Standorten Wangerooge, Helgoland und Sylt für Frühjahr und Herbst (HÜPPOP et al., 2009)... 137

Tabelle 11: Thermische Eigenschaften wassergesättigter Böden (nach SMOLCZYK 2001)........... 164

Tabelle 12. Flächenvergleich unter Anwendung naturschutzfachlicher Kriterien. 263

Tabelle 13: Vergleich der Trassenlängen für die Varianten über die Sandbank ggb. Umgehung der Sandbank Borkum Riffgrund. 269

List of abbreviations

AC	Alternating current
AIS	Automatic Identification System (for ships)
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas
AWI	Alfred Wegener Institute for Polar and Marine Research
BBergG	Federal Mining Act
BfN	Federal Agency for Nature Conservation
BFO	Spatial Offshore Grid Plan
BFO-N	Spatial Offshore Grid Plan North Sea
BFO-O	Spatial Offshore Grid Plan Baltic Sea
BGBl	Federal Law Gazette
BIAS	Baltic Sea Information on the Acoustic Soundscape
Birds Directive	Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds
BMUB	Federal Ministry for the Environment, Nature Conservation, Construction and Nuclear Safety
BNatSchG	Act concerning nature conservation and landscape management (Federal Nature Conservation Act)
BNetzA	Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railway
BSH	Federal Maritime and Hydrographic Agency
CMS	Convention on the Conservation of Migratory Species of Wild Animals
CTD	Conductivity, Temperature, Depth Sensor
DC	Direct current
DDT	Dichlorodiphenyltrichloroethane
DEPONS	Disturbance Effects on the Harbour Porpoise Population in the North Sea
EEZ	Exclusive Economic Zone
EIA	Environmental impact assessment
EIS	Environmental impact study
EMSON	Recording of marine mammals and seabirds in the German North Sea and Baltic Sea EEZs
EnWG	Act concerning electricity and gas supply (German Energy Act)
ERASNO	Recording of resting birds in the German North Sea and Baltic Sea EEZs
EUROBATS	Agreement on the Conservation of Populations of European Bats
FEP	Site Development Plan
FFH	Flora Fauna Habitat
FFH-RL	Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (Habitats Directive)
FFH-VP	Compatibility testing according to Art. 6 subsection 3 of the Habitats Directive or section 34 of the Federal Nature Conservation Act
FPN	North Sea Research Platform
HELCOM	Helsinki Convention

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

SEA Directive	Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment
TFEU	Treaty on the Functioning of the European Union
TSO	Transmission system operator
TOC	Total Organic Carbon
UBA	German Environment Agency
UVPG	Environmental Impact Assessment Act
VARS	Visual Automatic Recording System
WEA	Wind turbine
WindSeeG	Act concerning the development and promotion of offshore wind energy (Offshore Wind Energy Act - WindSeeG)

1 Introduction

1.1 Legal basis and tasks of the environmental assessment

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

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

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

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

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

1.2 Brief description of the content

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

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

and most important objectives of the Site Development Plan

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

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

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

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

1. areas; in coastal waters, areas can only be defined if the competent country has designated the areas as a possible subject of the Site Development Plan,
2. sites in the areas stipulated in accordance with paragraph 1; in coastal waters, sites may be stipulated only if the competent country has designated the sites as a possible subject of the Site Development Plan
3. the chronological order in which the specified sites are put out to tender according to part 3 section 2 of WindSeeG, including the specification of respective calendar years,
4. the calendar years in which the subsidised offshore wind turbines and the corresponding offshore connecting cable are to be put into operation in the specified sites,
5. the expected generation capacity of the offshore wind turbines to be installed in each of the specified areas and sites,
6. locations of converter platforms, collector platforms and, as far as possible, transformer platforms,
7. routes or route corridors for offshore connecting cables,
8. places at which the offshore connecting cables cross the border between the EEZ and coastal waters,
9. routes or route corridors for border-crossing power cables,
10. routes or route corridors for possible interconnections of the plants, routes or route corridors listed in points 1, 2, 6, 7 and 9, and
11. standardised technical and planning principles.

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

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

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

1.3.1 Introduction

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

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

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

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

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

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

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

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

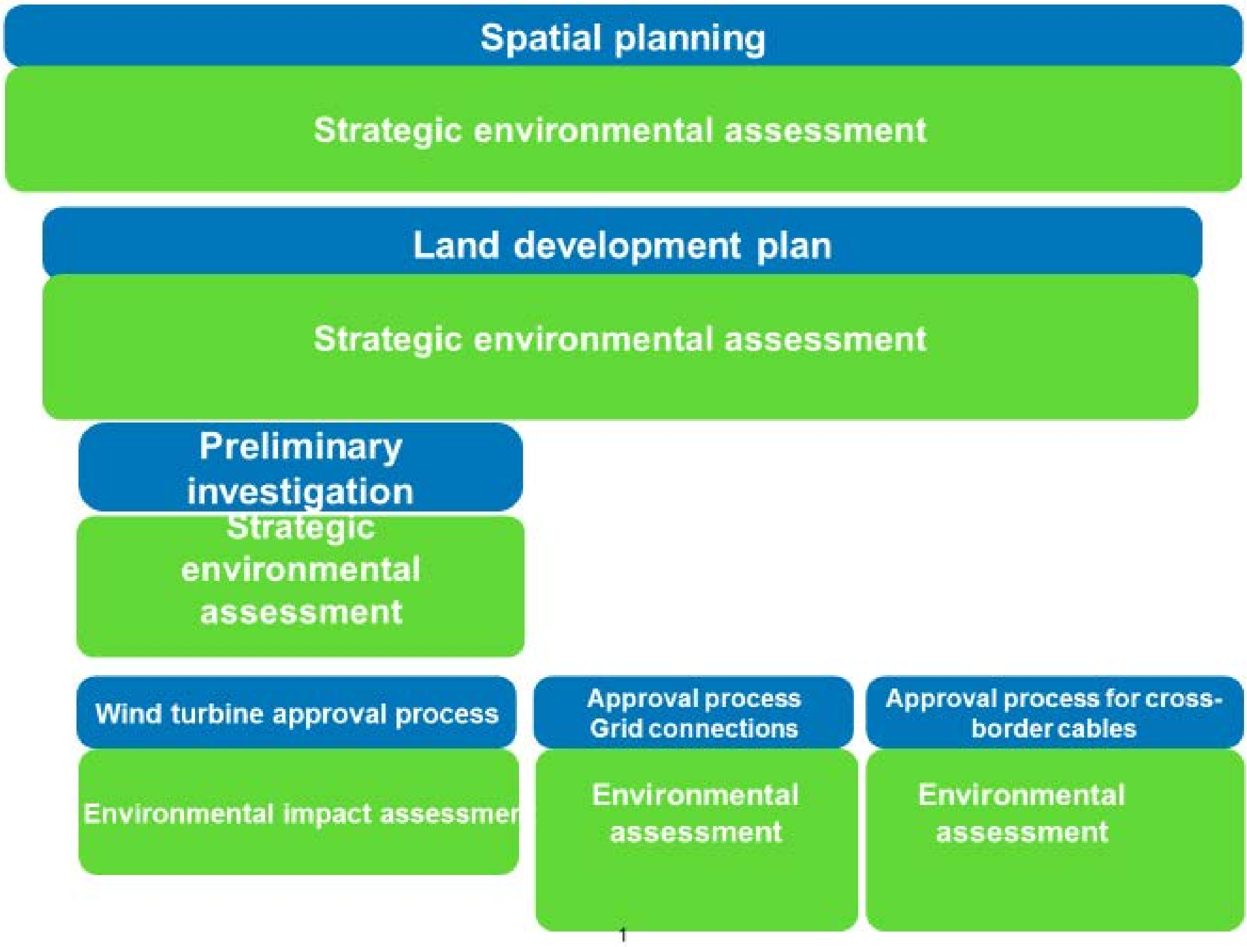


Figure 1: Overview of the staged planning and approval process in the central model.

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

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

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

Within the framework of the staged planning and approval process, all tests have in common the fact that environmental impacts on the protected assets listed in section 2 subsection 1 of the Environmental Impact Assessment Act, including their interactions, are considered.

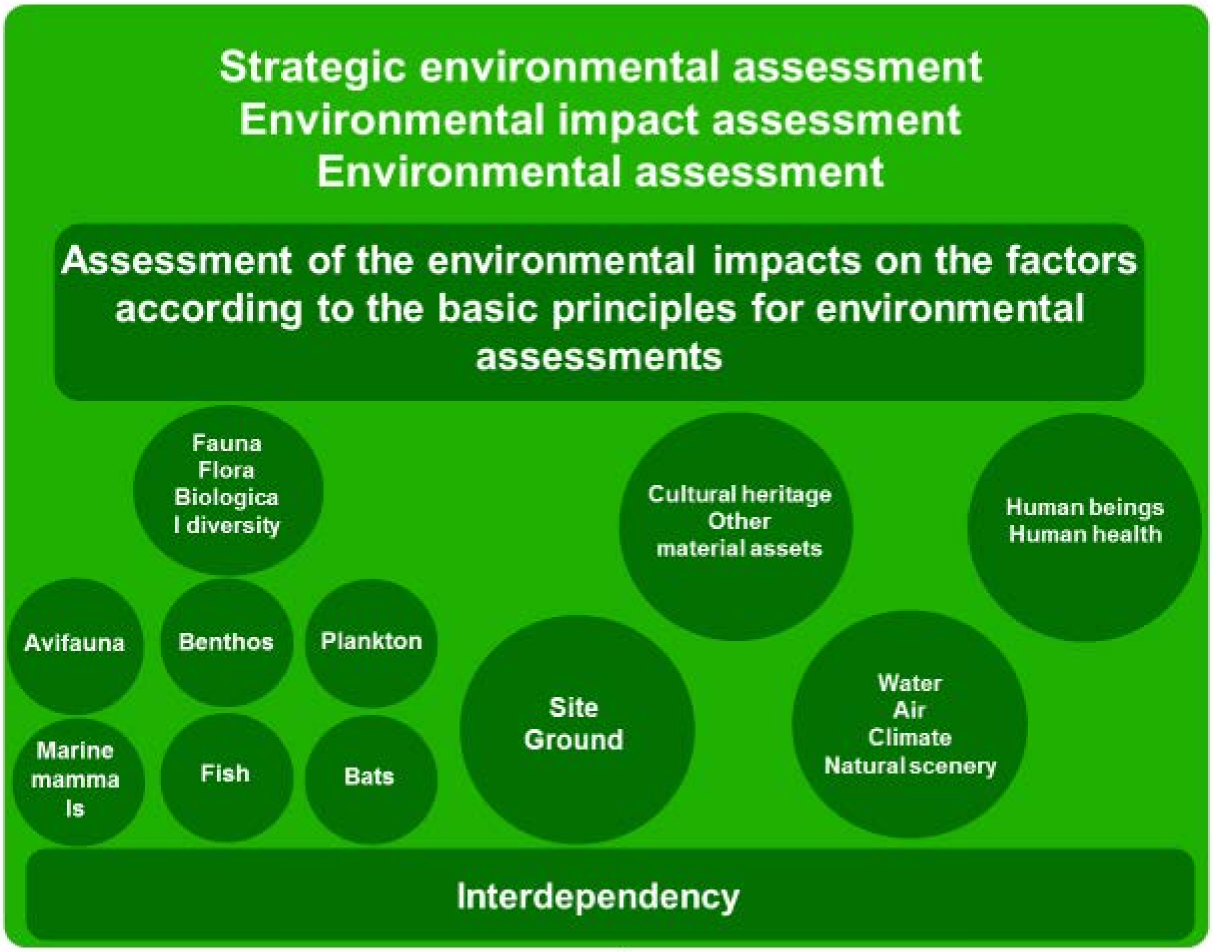
According to the definition found in section 2 subsection 2 of the Environmental Impact Assessment Act, environmental impacts in the sense of the Environmental Impact Assessment Act are direct and indirect effects of a project or the implementation of a plan or programme on the protected assets.

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

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

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

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



2

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

In detail, the staged planning process is as follows:

1.3.2 Maritime spatial planning (EEZ)

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

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

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

- for further economic uses,
- for scientific uses and
- for the protection and improvement of the marine environment.

Within the framework of spatial planning, specifications are mainly defined in terms of priority and restricted areas, as well as objectives and principles.

According to section 8 subsection 1 of the Federal Spatial Planning Act[4], when compiling spatial development plans, the body responsible for the spatial development plan shall conduct a Strategic Environmental Assessment to identify, describe and assess the likely significant impacts of the spatial development plan in question on the protected assets, including their interactions.

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

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

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

1.3.3 Site Development Plan

The next level is the Site Development Plan.

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

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

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

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

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

that the specifications to be assessed are inadmissible, in particular, if they

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

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

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

As the Site Development Plan is continuing the task of Federal Offshore Planning pursuant to section 17a of the Energy Industry Act, the SEA builds on the assessments already implemented for the preparation and updating of the Spatial Offshore Grid Plans. Reference is therefore made to the environmental reports, in particular the latest Spatial Offshore Grid Plan 2016/2017 for the North Sea EEZ[5].

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

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

As with the maritime spatial planning instrument, the assessment **focuses** on possible cumulative effects and possible transboundary impacts. Moreover, the Site Development Plan focuses on strategic,

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

technical and spatial alternatives, particularly for wind energy and power line applications.

1.3.4 Site investigation

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

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

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

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

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

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

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

Both the criteria of section 5 subsection 3 of the Offshore Wind Energy Act and the requirements of section 48 subsection 4 sentence 1 of the Offshore Wind Energy Act require assessment of whether the marine environment is endangered. With regard to the latter, it is necessary in particular to verify that pollution of the marine environment as defined in Article 1 subsection 1 no. 4 of the United Nations[6] Convention on the Law of the Sea is not a concern and that bird migration is not endangered.

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

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

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

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

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

In addition to the statutory specifications of section 73 subsection 1 sentence 2 of the Administrative Procedure Act[7], the plan must include the information contained in section 47 subsection 1 of the Offshore Wind Energy Act. The plan may be adopted only under certain conditions as listed in section 48 subsection 4 of the Offshore Wind Energy Act, and only if the marine environment is not endangered, in particular if pollution of the marine environment within the meaning of Article 1 subsection 1 no. 4 of the Convention on the Law of the Sea is

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

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

not a concern and bird migration is not endangered.

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

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

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

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

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

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

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

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

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

1.3.7 Cross-border cables (interconnectors)

According to section 133 subsection 1 in conjunction with subsection 4 of the Federal Mining Act[8], the construction and operation of a submarine cable in or on the continental shelf is subject to approval

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

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

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

1.3.8 Summary overviews of environmental assessments

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

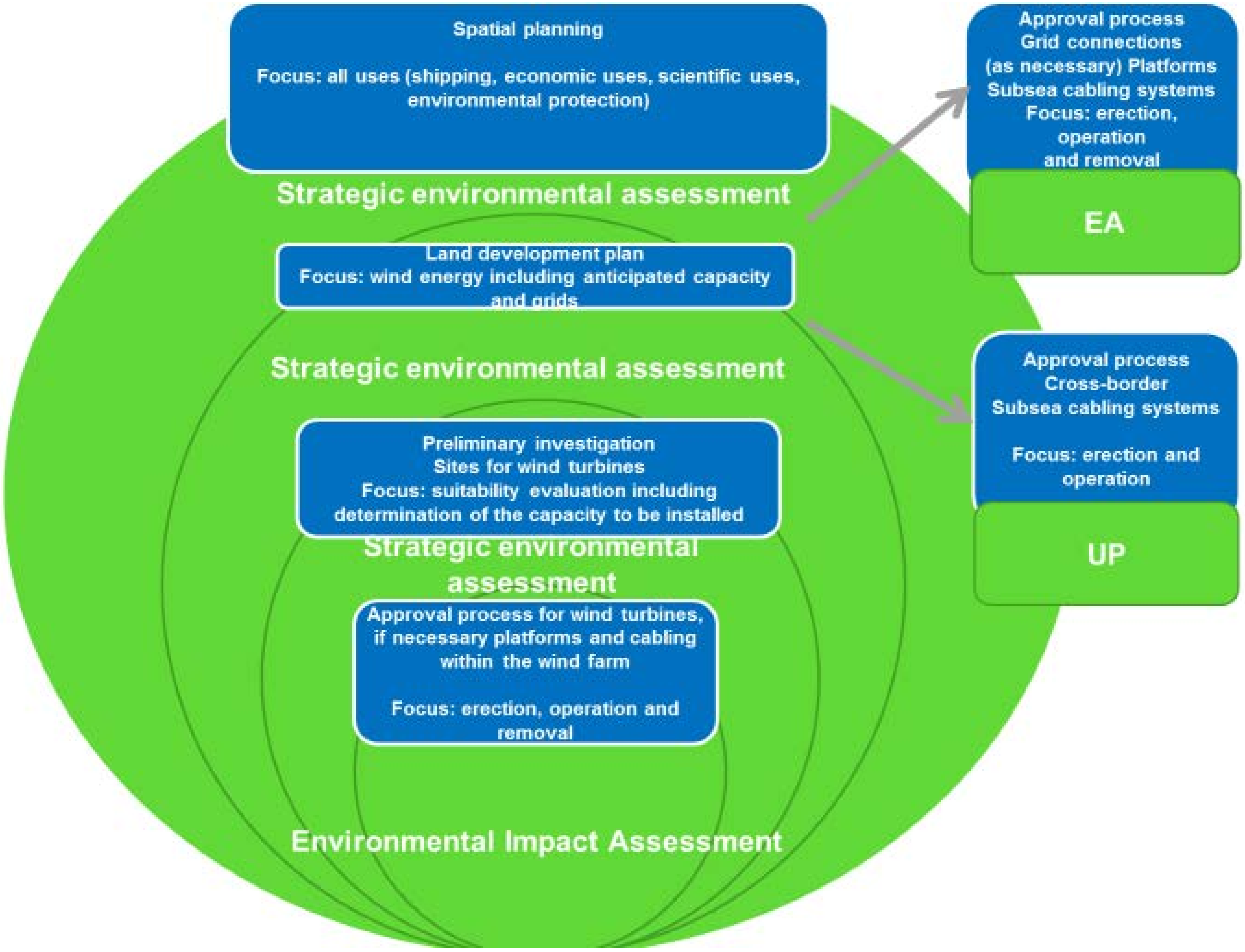


Figure 3: Environmental assessments in the staged planning and approval process, with emphasis on the assessment in question

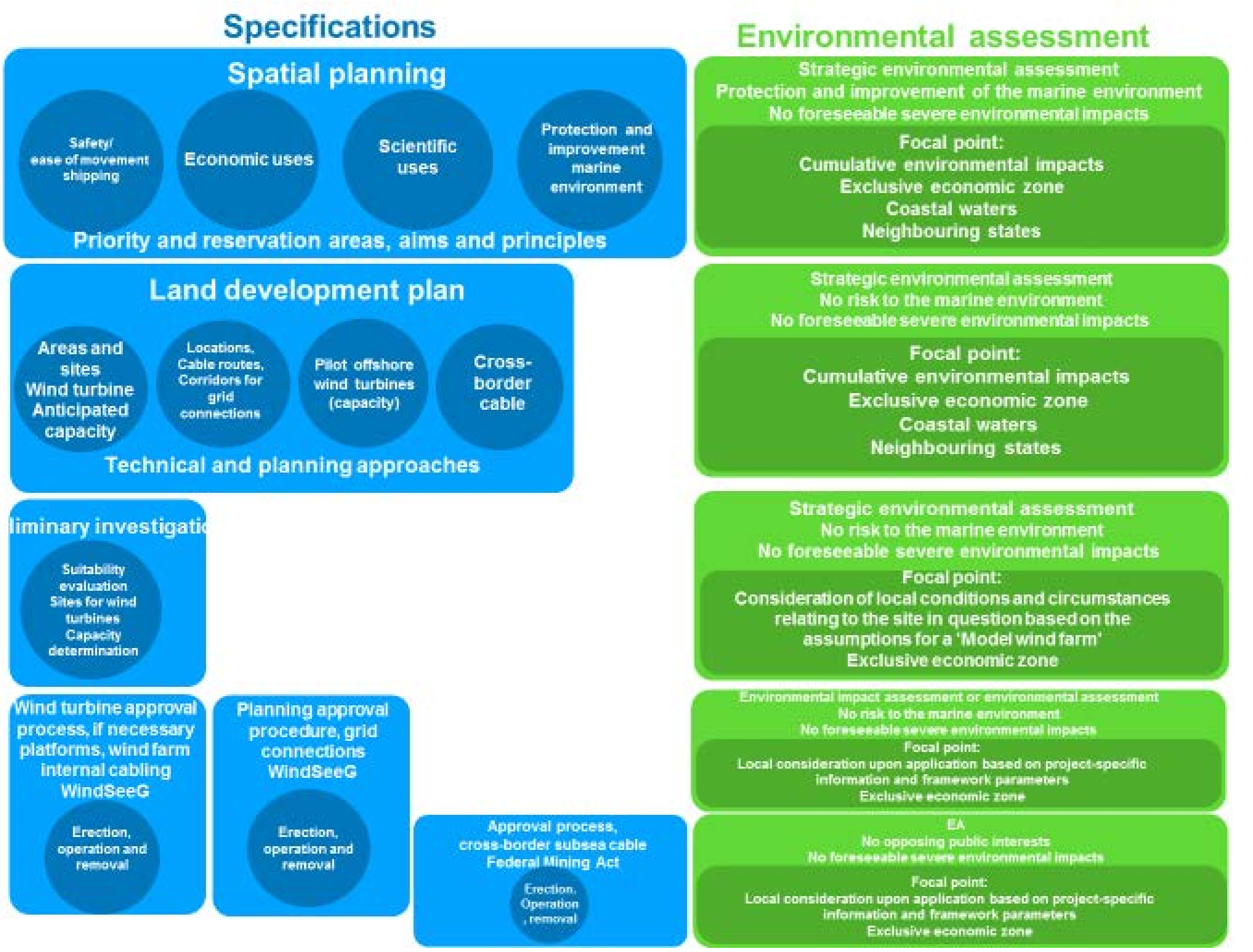


Figure 4: Object of the planning and approval procedures, with emphasis on environmental assessment

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

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

F ents in the planning and approval

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

procedure.

1.4 Presentation and consideration of environmental protection objectives

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

1.4.1 International conventions on the protection of the marine environment

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

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

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

The 1973 Convention for the Prevention of Pollution from Ships[9], developed under the auspices of the International Maritime Organization, provides the legal basis for environmental protection in maritime shipping. It is aimed at shipowners in particular so as to prevent operational discharges into the sea. The regulations on the discharge of sewage and garbage from ships (Annexes IV and V) are particularly relevant. Annex VI provides for the possibility of designating sulphur emission control areas. According to Art. 2 subsection 4 of MARPOL, the Convention also applies to offshore platforms. The planning principles include this requirement and provide details on emission reduction, including with regard to waste.

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

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

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

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

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

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

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

1.4.1.2 Regional conventions on the protection of the marine environment

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

The aim of the Trilateral Wadden Sea Cooperation and the 1997 Trilateral Monitoring and Assessment Programme between Denmark, the Netherlands and Germany is to preserve the diversity of biotopes in the Wadden Sea ecosystem. The principle is pursued so as to achieve a natural and self-sustaining ecosystem in which natural processes can continue undisturbed. A Wadden Sea plan with common cornerstones was adopted for this purpose. Measures to prevent and reduce impacts in the environmental report and the standardised planning principles include requirements for the lowest possible use of nature conservation areas. For the submarine cable systems, these objectives are taken into account through cable routing principles, such as bundling and the choice of the shortest possible route, which aim to achieve the most space-saving use possible, as well as planning principles on installation depth with regard to the 2K criterion and on cable crossings. However, the fact that the scope of the Site Development Plan and the environmental report only covers the EEZ and not coastal waters must also be taken into consideration.

- 1983 Agreement for Cooperation in Dealing with Pollution of the North Sea by Oil (Bonn Agreement)

The Agreement on cooperation between the North Sea states in dealing with pollution of the North Sea by oil and other harmful substances[12] requires the Contracting States to provide one another with full information on any damage which has occurred and the measures planned by the countries. The Site Development Plan takes into account the priority areas and distance regulations set out in the Spatial Development Plan for the North Sea so as to minimise conflicts with shipping that could cause oil spills. If possible, the specifications are made outside the conservation areas and legally protected biotopes.

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

[12] 1983 Agreement for Cooperation in Dealing with Pollution of the North Sea by Oil of 6 February 1990, Federal Law Gazette II 1990 no. 5 p. 70.

The objective of the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) is to protect the marine environment of the North-East Atlantic from risks related to anthropogenic pollution from all sources. This requires the use of the best available emission control technology (art. 2 subsections 2 and 3 of the OSPAR Convention). The standardised technology and planning principles define requirements for the reduction of emissions from the operation of wind farms, platforms and cables and include the consideration of conservation areas during planning. Moreover, one criterion for the provisions of section 5 subsection 3 no. 2 of the Offshore Wind Energy Act is that the marine environment is not endangered, and conflicts of use are also factored into the determination of sites.

- UNECE Convention on Environmental Impact Assessment (EIA) in a Transboundary Context (Espoo Convention[13])

The United Nations Economic Commission for Europe (UNECE) Convention requires the contracting parties to carry out an EIA and notify interested parties of planned projects that may have significant adverse environmental effects. The notification includes information on the planned project, including information on its transboundary environmental impacts, and indicates the nature of the possible decision. The party within whose jurisdiction a project is planned ensures that EIA documentation is prepared as part of the EIA process and submits it to the party concerned. The EIA documentation forms the basis for consultations with the party concerned in relation to matters such as the potential transboundary environmental impacts of the project and how to reduce and prevent them. The contracting parties ensure that the public concerned in the relevant state are informed about the project and given the opportunity to comment. The neighbouring countries were informed within the framework of Site Development Plan establishment and given the opportunity to comment.

- UNECE Protocol on Strategic Environmental Assessment (SEA Protocol)

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

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

1.4.1.3 Agreements specific to protected assets

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

The Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention)[14] of 1979 regulates the protection of species by means of restrictions on removal and use and the obligation to protect their habitats. Annex II on strictly protected fauna species also protects porpoises, divers and little gulls, for example. The contents also find their way into

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

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

the environmental impact assessment through species protection law.

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

The 1979 Convention on the Conservation of Migratory Species of Wild Animals[15] requires Contracting States to take measures to protect wild migratory species that cross boundaries and ensure their sustainable use. What are known as the range states, in which the threatened species are widespread, must preserve their habitats if they are important in order to protect the species from the risk of extinction (Art. 3 subsection 4 a of the Bonn Convention). Where practicable, they must also prevent or reduce adverse impacts of activities or obstacles which seriously impede, eliminate, compensate for or minimise the migration of the species (Art. 3 subsection 4 b of the Bonn Convention) and influences which endanger the species. The requirements for wildlife conservation and territorial protection law are examined and presented in the environmental report.

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

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

The 1995 Agreement on the Conservation of African-Eurasian Migratory Waterbirds[16] is particularly important in view of the importance of the North Sea for migratory birds listed in the Agreement. Migratory birds must be kept in a favourable conservation status or restored to a favourable conservation status on their migratory routes. The environmental report examines the impact of the Site Development Plan specifications on migratory bird movements in the EEZ (see chapters 0 and 5.2).

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

The 1991 Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas[17] provides for the protection of toothed whales other than sperm whales, specifically in the North Sea and Baltic Sea. In particular, a conservation plan was drafted in order to reduce the bycatch rate. The environmental report examines the effects of the specifications on mammals, and the standardised technical principles prescribe noise reduction and prevention measures, coordination of pile driving work, etc. for the protection of small cetaceans (see chapters 4.5 and 5.1). The actual implementation of these measures must be assessed in greater detail and regulated by the approval or planning approval authority based on the project-specific requirements, taking into account the special features of the relevant specific project area at approval level.

- Agreement on the Conservation of Seals in the Wadden Sea, 1991

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

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

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

The 1991 Agreement on the Conservation of Seals in the Wadden Sea[18] aims to establish and maintain a favourable conservation status for the Wadden Sea seal population. It includes rules on monitoring, removal and protection of habitats. The environmental report examines the likely significant impacts of the specifications on marine mammals (see chapters 4.5 and 5.1).

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

The 1991 Agreement on the Conservation of Populations of European Bats (EUROBATS)[19] aims to ensure the protection of all 53 European bat species by means of appropriate measures. The agreement is open not only to European states, but also to all range states that are part of the distribution range of at least one European bat population. As the most important instruments, the agreement provides for regulations on the removal of animals, the designation of important conservation areas and the promotion of research, monitoring and public relations work. Bats are a specially and strictly protected species according to section 7 subsection 2 nos. 13 and 14 of the Federal Nature Conservation Act. They are subject to species conservation assessment and are also protected pursuant to the Habitats Directive. Please see chapters 4.8 and 5.3.

- Convention on Biological Diversity, 1993

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

1.4.2 Environmental and nature conservation requirements at EU level

The material scope of application of the TFEU[21] and thus in principle also that of secondary law is extended if the Member States experience an increase in rights in an area outside their territory which they have transferred to the EU (ECJ, Commission/United Kingdom, 2005). In the field of protection of the marine environment, nature conservation or water protection, the applicability of the legal EU requirements is also valid for the EEZ.

The relevant EU legislation is to be taken into account:

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

Council Directive 337/85/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment[22] (codified by Directive 2011/92/EU of the

[18] Notice concerning the Agreement on the Conservation of Seals in the Wadden Sea, of 19 November 1991, Federal Law Gazette II No. 32 p. 1307.

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

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

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

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

European Parliament and of the Council of 13 December 2011 on the assessment of the implications of certain public and private projects on the environment)[23] has been transposed into national law by the Environmental Impact Assessment Act. As the Strategic Environmental Assessment – which is also regulated in this Act – refers in many regulations to the standards for environmental impact assessment, the EIA Directive also has an indirect effect on the preparation of plans subject to SEA.

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

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

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

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

- Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment (Strategic Environmental Assessment Directive, SEA Directive)

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

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

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

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

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

contains the information required pursuant to Article 5 in conjunction with Annex I.

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

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

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

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

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

In particular, the impacts on marine species and habitats are assessed and standardised technical and planning principles are established in order to reduce environmental impacts, including requirements for waste management and use of resources, and with regard to pollutants.

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

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

- Rules for sustainable fishing under the Common Fisheries Policy

The EU has exclusive competence in the field of fisheries policy (see Article 3 subsection 1d of the Treaty on the Functioning of the European

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

[28] Directive 2009/147/EC of the European Parliament and of the Council on the conservation of wild birds (Birds Directive) of 30 November 2009, OJ L 20/7 of 26 January 2010.

Union). The regulations include, for example, catch quotas based on maximum sustainable yield, multi-annual management plans, a landing obligation for bycatches, and support for aquaculture facilities. The use of the EEZ for fishing purposes should be assessed as a matter of importance in the specifications of the Site Development Plan.

1.4.3 Environmental and nature conservation requirements at national level

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

- Act for regulating water resources (WHG)

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

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

According to section 56 [30]subsection 1 of the Act concerning nature conservation and landscape management (Federal Nature Conservation Act, BNatSchG), the Federal Nature Conservation Act is also applicable in the EEZ with the exception of landscape planning requirements. According to section 1 of the Federal Nature Conservation Act, the objectives of the Federal Nature Conservation Act include biodiversity, the efficiency and functionality of the ecosystem and the diversity, uniqueness, beauty and recreational value of nature and the landscape. Sections 56 ff. of the Federal Nature Conservation Act contain requirements for marine nature conservation. With regard to the environmental report as part of the preparation of the Site Development Plan, it contains requirements on the conservation of species and natural habitats as well as the intervention regulation, which requires certain assessments to be reflected in the environmental report. This concerns the protection of legally protected biotopes pursuant to section 30 of the Federal Nature Conservation Act, the destruction or other significant impairment of which is prohibited. Furthermore, an impact assessment in accordance with section 34 subsection 2 of the Federal Nature Conservation Act must be carried out for plans in conservation areas or for effects on the protective purpose of conservation areas. With regard to species protection, section 44 subsection 1 of the Federal Nature Conservation Act prohibits the injuring or killing of wild animals of specially protected species or significant disturbance of wild animals of strictly protected species and of European bird species during reproduction, rearing, moulting, wintering and migration periods.

Within the framework of the specifications, the sites of the conservation areas are avoided as far as possible when selecting the routes. In cases where this is not possible, an impact assessment is carried out as part of the environmental assessment (see chapter 6) in

[29] Water Resources Act of 31 July 2009 (Federal Law Gazette I p. 2585), as last amended by Article 1 of the Act of 18 July 2017, Federal Law Gazette I p. 2771).

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

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

- Act concerning the environmental impact assessment (UVPG)

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

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

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

- Protected area regulations

In accordance with section 57 of the Federal Nature Conservation Act, the existing nature conservation and FFH areas in the German EEZ were included in the national territory categories and declared nature conservation areas in accordance with the ordinances of 22 September 2017. They were partially regrouped in this context. For example, the Ordinance on the establishment of the conservation area "Sylt Outer Reef – Eastern German Bight" (NSGSylV)[31], the Ordinance on the establishment of the conservation area "Borkum Reef Ground" (NSGBRgV)[32] and the Ordinance on the establishment of the conservation area "Dogger Bank" (NSGDgbV)[33] now include the conservation areas "Sylt Outer Reef – Eastern German Bight", "Borkum Reef Ground" and "Dogger Bank". This does not result in any differences in terms of spatial extent. On isolated occasions, some species (the great skua (*Stercorarius skua*) and the pomarine skua (*Stercorarius pomarinus*)) were placed under protection for the first time.

Within the framework of the specifications, the sites of the conservation areas are avoided as far as possible when selecting the routes. In cases where this is not possible, an impact assessment is carried out as part of the environmental assessment (see chapter 6) in order to verify whether these areas can be significantly affected in the elements relevant for their protective purposes. Reference is made to the protective purposes of the ordinances in the impact assessment according to section 34 subsection 2 of the Federal Nature Conservation Act. Nature reserves are excluded with regard to the specification of areas and sites in these areas for wind energy utilisation. The specifications were then reviewed to determine whether there was any danger to the marine environment, or whether conflicts of use were used as a criterion for the selection. As a result, areas and sites in the former Cluster 5 of the Spatial Offshore Grid Plan for the North Sea (BFO-N) – now Area N-5 of the Site Development Plan – were initially assessed or not included. The planning principles include the exclusionary effect of areas and sites in conservation areas, as well as requirements concerning minimum distances to conservation areas and the dismantling of installations, noise reduction, emission reduction, bundling of submarine cable systems, careful cable laying procedures, etc. Reference is also made to chapter 4.4 of the Site Development Plan.

1.4.4 The Federal Government's energy and climate conservation aims

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

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

In the wake of the latest reform of the Renewable Energy Sources Act in 2016, section 1

[31] Ordinance on the establishment of the conservation area "Sylt Outer Reef – Eastern German Bight" of 22 September 2017, Federal Law Gazette I p. 3423.

[32] Ordinance on the establishment of the conservation area "Borkum Reef Ground" of 22 September 2017, Federal Law Gazette I p. 3395.

[33] Ordinance on the establishment of the conservation area "Dogger Bank" of 22 September 2017, Federal Law Gazette I p. 3400.

subsection 2 of the Renewable Energy Sources Act 2017 states that the objective is to increase the proportion of electricity generated from renewable energies in gross electricity consumption to

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

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

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

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

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

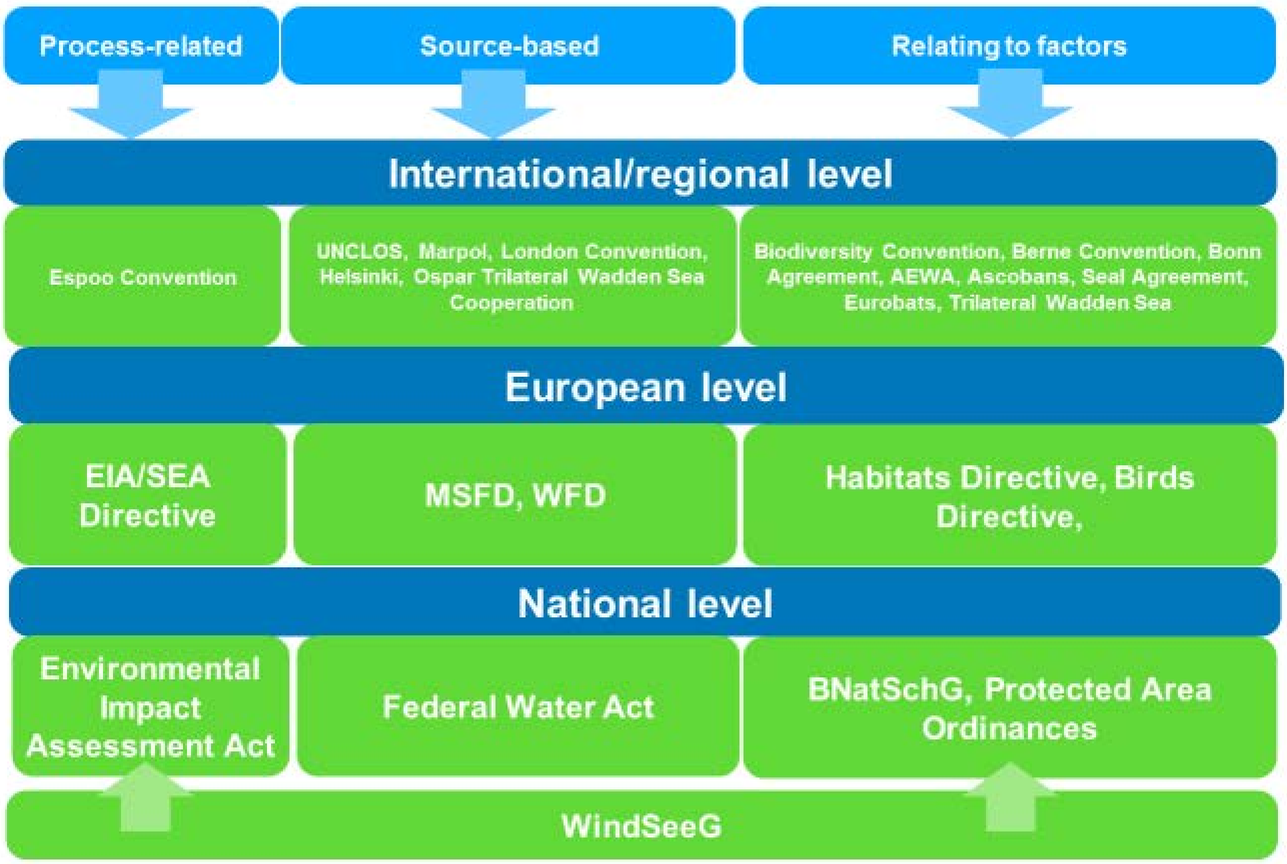


Figure 6: Overview of the standards of the relevant legal acts for the SEA.

1.5 Strategic Environmental Assessment methodology

1.5.1 Introduction

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

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

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

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

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

1.5.2 Area of investigation

The description and assessment of the state of the environment relates primarily to the North Sea EEZ, for which the Site Development Plan essentially defines rules. The SEA area of investigation covers the entire German North Sea EEZ (Figure 7) should be noted that the data availability for the region up to shipping route 10 is significantly better than for the area north-west of shipping route 10 due to the available project-related monitoring data.

For the area northwest of shipping route 10, the Site Development Plan makes statements on possible routes, route corridors or gates for Interconnectors. Based on the available sediment data and findings from monitoring for the "Dogger Bank" protected area, it is also possible to describe and assess the state of the environment and potential environmental effects in this area.

The adjacent coastal waters and the adjacent regions of the neighbouring states are not directly covered by the Site Development Plan, but they will be considered in the cumulative and transboundary perspective of this SEA (chapters 4.12 and 4.13).

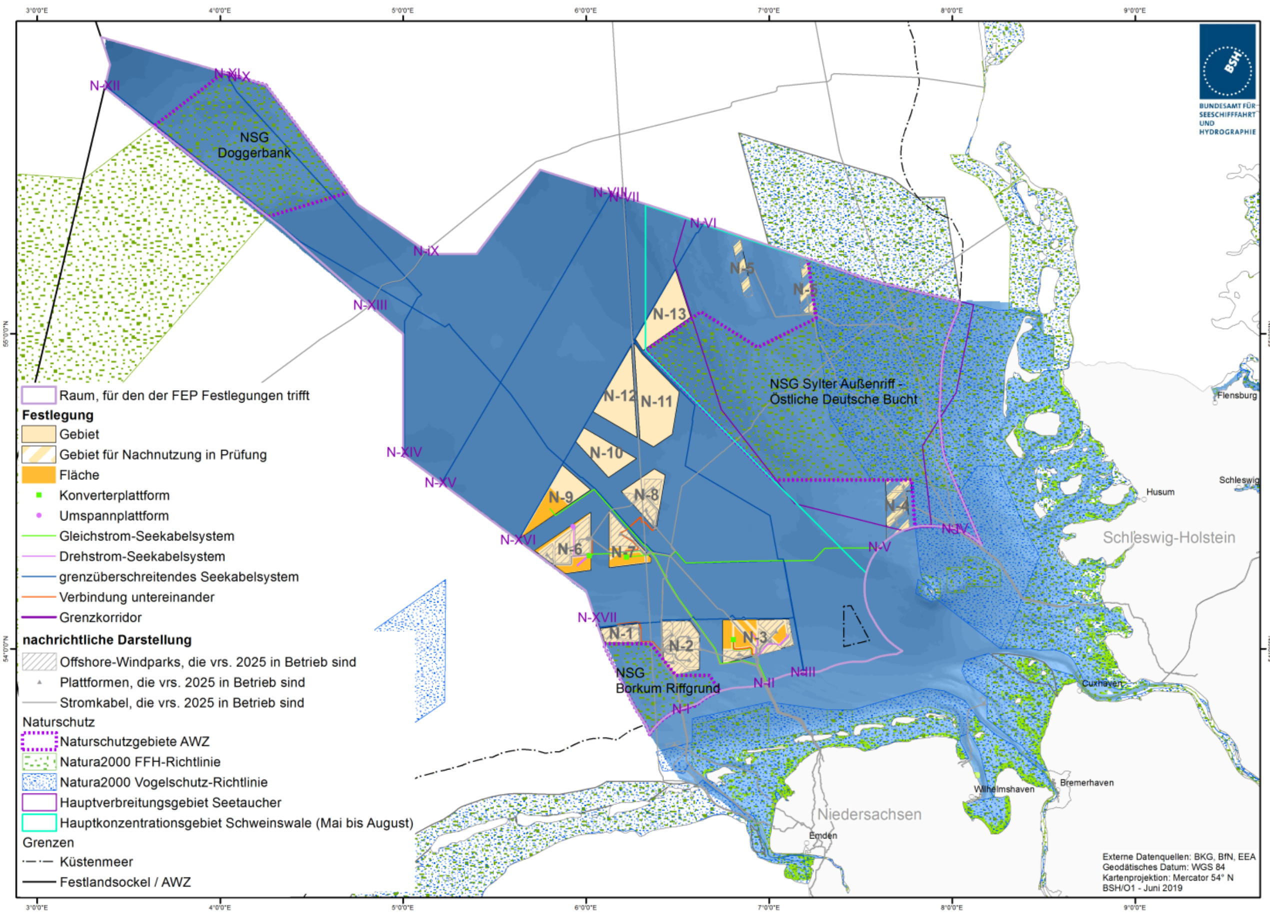


Figure 7: Representation of the investigation area of the SEA for the North Sea for the site development plan.

1.5.3 Carrying out the environmental assessment

The assessment of the likely significant environmental effects of the implementation of the Site Development Plan includes secondary, cumulative, synergistic, short-, medium- and long-term, permanent and temporary, positive and negative effects related to the protected assets. Secondary or indirect effects are those that are not immediate and therefore may only become effective after some time and/or at other locations (WOLFGANG & APPOLD 2007; SCHOMERUS et al. 2006). Occasionally, there is also reference to consequences or interrelationships (see chapter 4.11).

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

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

- the probability, duration, frequency and reversibility of the effects;
- the cumulative nature of the effects;
- the transboundary nature of the effects;

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

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

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

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

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

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

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

- Site
- Soil
- Water
- Plankton
- Biotopes
- Benthos
- Fish
- Marine mammals
- Avifauna
- Bats
- Biodiversity
- Air
- Climate
- Landscape
- Cultural heritage and other material assets
- Human beings, in particular human health

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

- Qualitative descriptions and evaluations
- Quantitative descriptions and evaluations
- Evaluation of studies and technical literature
- Visualisations
- Worst-case assumptions
- Statistical evaluations, modelling and trend estimates (e.g. regarding the state of the art of installations)
- Assessments by experts / the specialist community

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

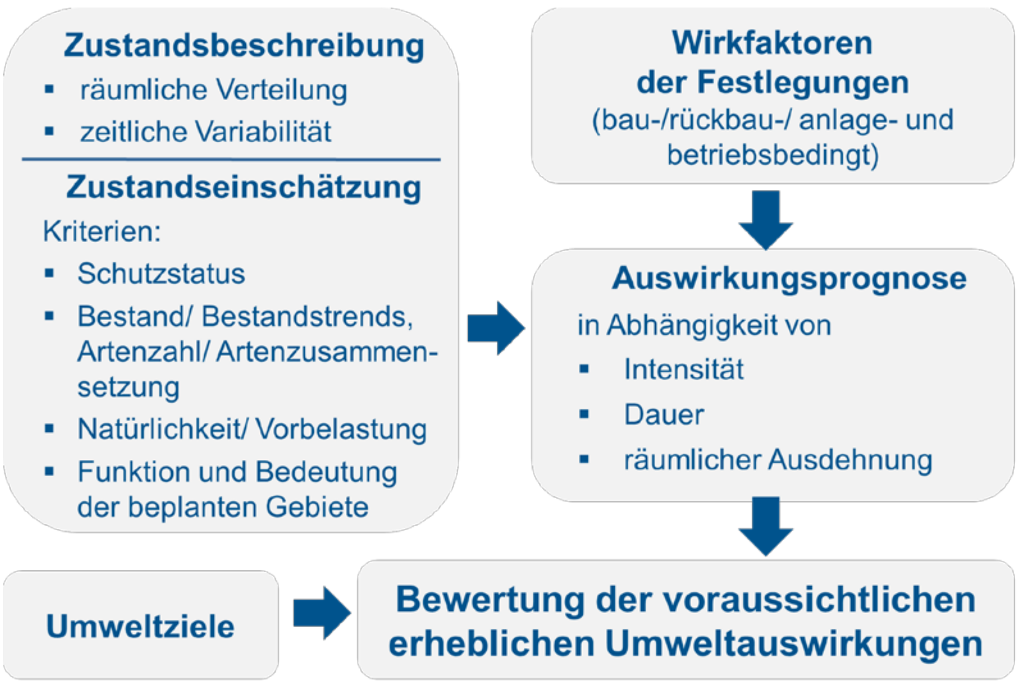


Figure 8: General methodology for assessing the likely significant environmental effects.

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

1.5.4 Criteria for status description and assessment

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

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

Area/Soil

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

Benthos

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

Biotopes

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

Fish

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

Marine mammals

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

Seabirds and resting birds

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

Migratory birds

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

1.5.5 Specific assumptions for assessment of likely significant environmental effects

The likely significant effects of the implementation of the Site Development Plan on the marine environment are described and assessed in relation to protected assets, based on the status assessment as described above, separately for areas and sites, platforms and submarine cable systems. The following table sets out the potential environmental effects, based on significant factors, that form the basis for the assessment of the likely significant environmental effects. The effects are differentiated according to whether they are due to construction, dismantling or operation, or are caused by the system itself.

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

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

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

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

<u>Cumulative assessment</u>

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

To assess the cumulative effects, it is necessary to assess the extent to which a significant adverse effect can be attributed to the combined rules of the plan. Assessment of the sites is carried out at the level of this sectoral plan based on the current state of knowledge in accordance with Art. 5 subsection 2 of the SEA Directive. The position statement on the cumulative assessment of diver habitat loss in the German North Sea (BMU 2009) and the noise protection concept of the BMU (2013) form an important basis for this assessment.

Interdependency

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

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

Areas and sites, including the expected generation capacity:

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

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

The Strategic Environmental Assessment takes particular account of the following:

- Turbines that are already in operation (as reference and initial load)
- Transfer of the average parameters of the systems already in operation to the sites to be planned in the central model
- Assumption that existing projects will be implemented within the scope of the transitional phase on the basis of an effective approval (worst-case scenario)
- Forecast of certain technical developments.

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

Table 2: Parameters for the consideration of areas and sites

	Scenario 1	Scenario 2
Capacity per turbine [MW]	9	15
Hub height [m]	Approx. 125	Approx. 175
Height of the lower rotor tip [m]	Approx. 26	Approx. 50
Rotor diameter [m]	Approx. 200	Approx. 250
Swept area of the rotor [m²]	Approx. 30,800	Approx. 49,100
Total height [m]	Approx. 225	Approx. 300
Diameter of foundation [m]*	Approx. 8.5	Approx. 12
Site foundation excl. Scour protection [m²]	Approx. 57	Approx. 113
Diameter of scour protection [m]	Approx. 43	Approx. 60
Site foundation incl. Scour protection [m²]	Approx. 1,420	Approx. 2,830

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

With regard to the information on hub height, it should be noted that point no. 3.5.1 (8) in the North Sea spatial development plan provides for a 125 m height limit for wind turbines within sight of the coast and islands. Accordingly, this requirement was applied in scenario 1.

As sections 19, 6 of the Federal Regional Planning Act basically provide for the possibility of a target deviation procedure for deviation from Maritime Spatial Planning targets and the height limit is of no relevance to non-visible installations, a hub height of 175 m was used for scenario 2.

<u>Locations for platforms (transformer or residential platforms)</u>

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

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

Grid connection Transformer/residential platforms*	66 kV	155 kV
Spec. Length of cabling within the wind farm [km/MW]	Approx. 0.12	Approx. 0.12
Number of transformer platforms	0	2
Number of residential platforms	1	0
Diameter of foundation [m]**	Approx. 10	Approx. 2 x 10
Site foundation excl. Scour protection [m²]	Approx. 80	Approx. 160
Diameter of scour protection [m]	Approx. 50	Approx. 2 x 50
Site foundation incl. Scour protection [m]	Approx. 2,000	Approx. 4,000

* The data on transformer/residential platforms refers to the number of transformer/residential platforms per area (only for completions from 2026) for the various connection concepts. Only the length of the farm's internal cabling is dependent on the anticipated capacity and was determined on the basis of existing plans. Converter platforms also have to be taken into account, but the number of these does not differ according to the connection system.

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

<u>Routes and route corridors for submarine cable systems</u>

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

Table 4: Parameters for the consideration of submarine cable systems

Submarine cabling systems	
Cable trench width [m]	Approx. 1
Number of intersections	Approx. 400
site of intersections [m²]	Approx. 900
Number of converter platforms	16
site of converter platforms [m²]	Approx. 600

Relevant planning and technical principles

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

The Site Development Plan also includes some planning principles that are not related to the mitigation of environmental effects. As these are based on Maritime Spatial Planning objectives, they are binding and must be observed. This concerns impairment of the safety and ease of traffic, implementing the objective of Maritime Spatial Planning 3.5.1 (2). This states that the construction and operation of power generation systems in priority areas for wind energy must not effect traffic safety. The planning principle of shipping crossing priority and reserved areas by the shortest possible route also implements a maritime spatial planning objective for the Site Development Plan (see spatial development plan 3.3.1 (4) (North Sea), according to which the shortest possible route is to be used when the priority areas defined for shipping are to be crossed by submarine cables in order to derive the energy generated in the EEZ). The remaining planning principles relating to distance and area requirements are used for the stability of the systems, the safety of the laying, a sufficient safe distance in the event of repairs and exclusion of mutual thermal influence of the submarine cable systems. When selecting the specific distances or site requirements, as little use of the site as possible was taken into consideration, and will be examined under the protected assets Soil/area and Avifauna.

With regard to the technical principles, a DC system as a voltage-sourced high-voltage DC transmission with a voltage level of +/- 320 kV was already specified as part of the North Sea BFO and was therefore also the subject of the BFO's environmental assessment. In the Site Development Plan, the standard transmission power was increased by 100 MV compared to the BFO in order to minimise the number of and space required for converter platforms and routes for the distribution of wind power. As there has to be compliance with the 2K criterion (see planning principle 4.4.4.8) anyway, this is unlikely to have any significant environmental impacts. The rule of the 66 kV connectivity concept reduces the number of platforms required and is therefore not expected to have a significant environmental impact.

1.5.6 Fundamentals of the assessment of alternatives

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

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

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

In detail, this environmental report examines spatial and technical alternatives in addition to the zero alternative.

1.6 Data sources and indications of difficulties in compiling the documents

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

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

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

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

This environmental report describes and assesses the current state of the environment and presents the likely development if the plan is not implemented. The likely significant environmental effects resulting from the implementation of the plan are also forecast and assessed.

A detailed description and assessment of the state of the environment forms a basis for the assessment of possible effects (chapter 2). The description and assessment of the current state of the environment and the likely development if the plan is not implemented (chapter 3) have been produced with regard to the following protected assets:

- Area/ Soil
- Water
- Plankton
- Biotopes
- Benthos
- Fish
- Marine mammals
- Resting and migratory birds
- Bats
- Biodiversity
- Air

- Climate
- Scenery
- Cultural heritage and other material assets
- Human beings, in particular human health
- Interrelationships between protected assets.

1.6.1 Overview of data source

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

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

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

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

1.6.2 Indications of difficulties in compiling the documents

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

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

1.6.2.1 Soil/Area and biotopes

- There has been no extensive, detailed mapping to date of sediment distribution in the EEZ outside the nature conservation areas: the description and evaluation of environmental effects with regard to the soil as a protected asset are based primarily on the evaluation of selective data collection. In particular, there is no comprehensive sediment description for the detailed distribution of coarse sand/fine gravel sites and residual sediments in the form of gravel, stones and rocks.
- Detailed and extensive mapping of marine biotopes in the EEZ is currently being developed as part of R&D projects ongoing at the Federal Agency for Nature Conservation, with spatial emphasis on nature conservation areas. There is no detailed mapping to date of the biotopes, including the legally protected biotopes according to section 30 of the Federal Nature Conservation Act, in the EEZ outside the nature conservation areas
- Please see planning principle 4.4.4.8 for assessment of compliance with measures regarding temperature increases in the sediment.

1.6.2.2 Benthos

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

1.6.2.3 Fish

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

1.6.2.4 Seabirds and resting birds

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

1.6.2.5 Migratory birds

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

1.6.2.6 Marine mammals

- The data availability can currently be described as very good: the data is systematically quality-assured and used for studies, so the current state of knowledge on the occurrence of marine mammals in German waters can also be classified as good.
- The most comprehensive data source is provided by data from environmental impact studies and the monitoring of offshore wind farms. Data is collected regularly as part of the monitoring of nature conservation areas on behalf of the Federal Agency for Nature Conservation. Finally, research projects provide data on specific issues. SCANS observations are providing information for the entire distribution area of harbour porpoise so as to allow the abundance of the entire population of harbour porpoise to be assessed.

1.6.2.7 Bats

- There is a lack of knowledge about the quality and quantity of migratory bat populations in the North Sea.
- There is currently a lack of sufficient knowledge of the effects of offshore construction. Knowledge from coastal waters and on land is only transferable to a very limited extent due to the different conditions.
- The species-specific risk of bats colliding with offshore wind turbines is largely unknown.

1.6.2.8 Summary

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

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

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

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

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

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

2 Description and assessment of state of the environment

2.1 Introduction

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

As at July 2018, 38 offshore wind farms have been approved in the North Sea EEZ (five under construction and 16 in trial operation), while applications have been submitted for an additional four offshore wind farms. The first offshore wind farm to go into trial operation in 2010 was the "alpha ventus" offshore test field, with 12 wind turbines. There are currently 16 wind farms with 958 wind turbines in trial operation, and five wind farms with 275 wind turbines are under construction.

2.2 Soil/Area

2.2.1 Protected asset Land

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

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

2.2.2 Data availability

The map of sediment distribution in the German North Sea (LAURER et. al, 2014; GPDN project) provides the primary basis for the description of surface sediments in the North Sea areas, in addition to the data and reports on site investigations from the Federal Maritime and Hydrographic Agency's own investigations and procedures. So far, however, there is no widespread sediment and biotope mapping of the North Sea EEZ. The description and assessment of the environmental impacts with regard to soil as a protected asset is based primarily on the evaluation of selective data surveys (e.g. the 2014 map of sediment distribution according to LAURER et al.). In particular, there is no comprehensive sediment description for the distribution of coarse sand/fine gravel sites and residual sediments in the form of gravel, stones and rocks.

The descriptions of the structure of the near-surface subsoil are essentially based on the drilling and pressure sounding operations and reports from site investigations, from projects such as Geopotenzial Deutsche Nordsee (GPDN, Geopotential German North Sea) and SGE-Baugrund, the literature and the Federal Maritime and Hydrographic Agency's own investigations and evaluations.

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

2.2.3 Geomorphology

The planning area under consideration in the German EEZ of the North Sea extends from the seaward boundary of the coastal waters of Lower Saxony and Schleswig-Holstein to shipping route 10, which crosses the German EEZ from the southwest to the northeast. The old Elbe-Urstromtal Valley divides the planning area into a western and an eastern part.

In the western part of the planning area under consideration, the seabed drops relatively evenly from about 18 m in the southwest to 36 m heading eastwards in the direction of the old Elbe-Urstromtal Valley west of Helgoland, and to up to 52 m in a northward direction in the northern part of the Elbe-Urstromtal Valley. Water depths of between 25 m and 35 m occur in areas N-1 to N-3 situated between the traffic separation areas, while water depths of 35 m to about 50 m are reached in areas N-6 to N-13 north of the traffic separation areas.

This western part of the planning area and the old Elbe-Urstromtal Valley are characterised by a largely flat seabed relief. Along the 12-nautical-mile boundary to the coastal waters of Lower Saxony, the offshoots of tongue reefs in the sense of REINECK & SINGH (1978) (shoreface-connected sand ridges) extend into areas N-1 to N-3 and submarine cable routes situated between the traffic separation areas. These tongue reefs (sand ridges) run in a northwest to southeast direction and are subject to pronounced sediment dynamics.

The planning area east of the old Elbe-Urstromtal Valley has water depths of 12 m in the east (Amrumbank) to about 45 m to the northwest, at the transition to the Elbe-Urstromtal Valley. In contrast to the western part and the old Elbe-Urstromtal Valley, the eastern part of the planning area is characterised by a very unsettled seabed relief and markedly heterogeneous sediment distribution. The two western parts of area N-5 in the north of the EEZ are located in the area of submarine ridges extending from the Danish continental shelf into the German EEZ. Water depths of about 25 m to 40 m are reached here. The part of the N-5 area further to the east has water depths of between 18 m and 23 m and is located in the vicinity of a soil structure west of Sylt that runs northwest to southeast.

Water depths in the N-4 area north of Helgoland range from 21 m at the EEZ boundary in the south to 27 m in the northern part of the area.

2.2.4 Sediment distribution on the seabed

The classification of surface sediments according to LAURER et al. (2014, Figure 2) shows a sediment composition for both the areas and the submarine cable systems in the Site Development Plan consisting largely of sands with a varying fine grain content (clay and silt).

The sediment composition of the seabed surface in areas N-1, N-2 and N-3 and of the submarine cable systems between the traffic separation areas consists mainly of fine and medium sands with a fine grain content mostly less than 5%. The fine grain content is potentially up to 10%, but only in the eastern part of area N-3. Coarse sands, gravel and, in certain areas, rock deposits can be found in the area of the Borkum Reef Ground (area N-1 and the western part of area N-2).

The surface sediments in areas N-6 to N-13 and submarine cable systems mainly consist of fine and medium sands in the western planning area north of the traffic separation areas and in the old Elbe-Urstromtal Valley. The fine grain content here is predominantly between 5% and 20%. In area N-13, located in the Elbe-Urstromtal Valley, the fine grain content can reach 50% at certain points. Site investigations in areas N-6 and N-7 and adjacent areas show that rock deposits also have to be expected in this region.

The surface sediments in areas N-4 and N-5 and the submarine cable systems in the eastern part of the planning area (east of the Elbe-Urstromtal Valley) have a comparatively heterogeneous composition. Coarse sands and gravel can also be found in some areas, in addition to fine and medium sands. The fine grain content is rarely more than 5%. There are Pleistocene elevations in the eastern planning area which were formed and partially levelled as the sea level rose. These elevations mostly show a characteristic composition of residual and relict sediments consisting of coarse sands, gravel and rocks. However, these elevations can also be relatively sandy in some areas. These relict sediments can be found mainly in parts of area N-5 and sporadically in the vicinity of the submarine cable systems, where they cross these elevations.

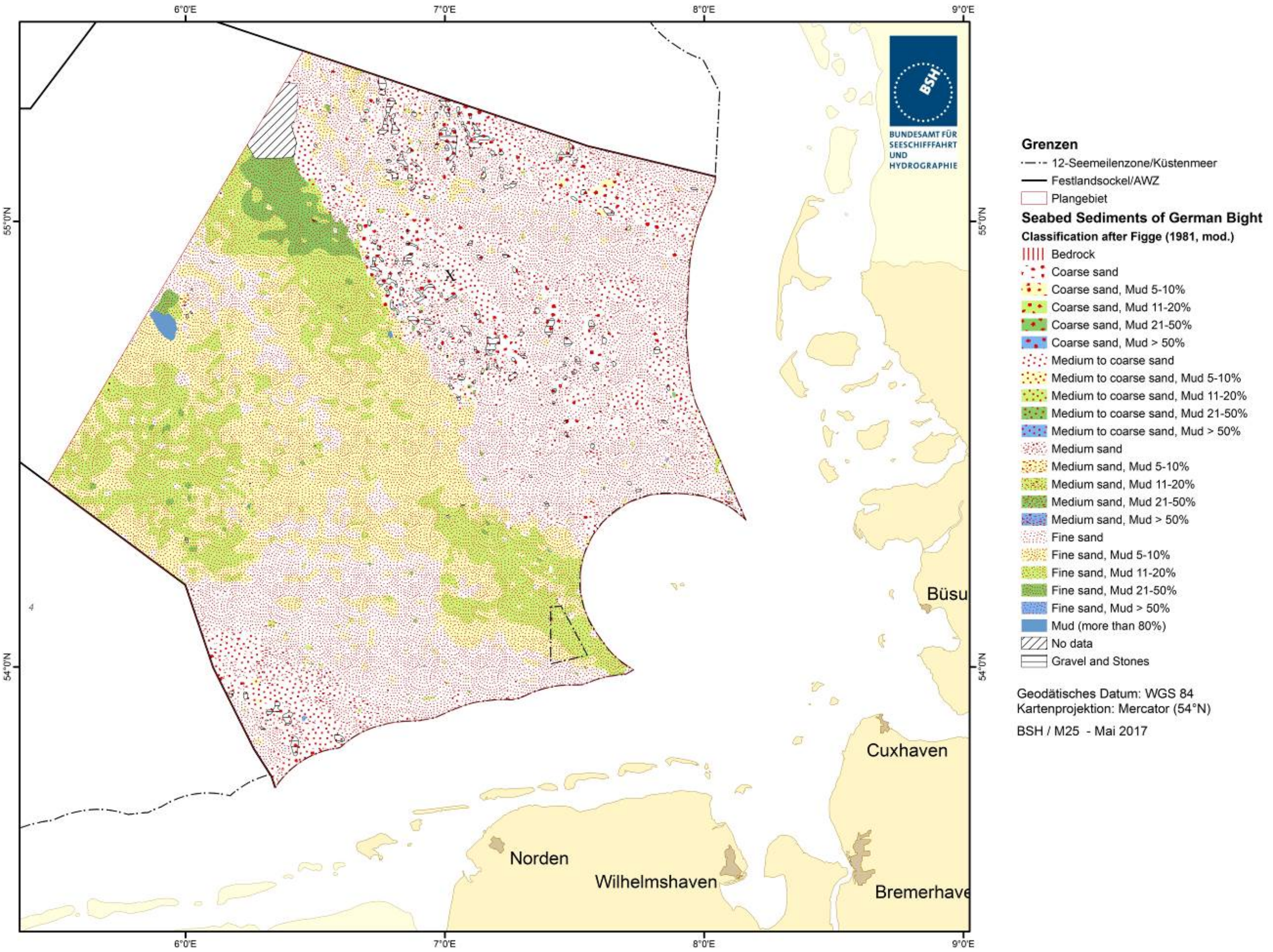


Figure 9: Sediment distribution in the EEZ (LAURER et al. 2014). The classification is based on FIGGE (1981). Source: http://www.gpdn.de

2.2.5 Geological structure of the near-surface subsoil

Sediment samples and boreholes were prepared and classified based on soil classes for construction purposes (DIN 18196) as part of the "Shelf Geo-Explorer Baugrund" ("SGE-Baugrund", Shelf Geo-Explorer Site) project funded by the BMU. Sediment samples and boreholes and their layer descriptions were used for the description of the seabed surface and the near-surface subsoil. These were compiled as part of various R&D projects (including "SGE-Baugrund" and Geopotenzial Deutsche Nordsee), and prepared and classified according to soil classes for construction purposes. The first 4 to 5 m or so of the subsoil are described.

The sediment composition of the upper seabed in areas N-1 to N-13 and the planned submarine cable systems along shipping route 10 in the western part of the planning area consists mainly of fine and medium sands of soil classes SE (closely graded sands), SW (well-graded sand/gravel mixtures) and SI (alternately graded sand/gravel mixtures, non-cohesive sands). The fine grain content is usually less than 5%. Fine grain contents of up to 15% or more are found only occasionally. These sands are generally of loose to medium density, but they may also be dense in areas beneath a loose top layer. Silts, clays and peats and coarse sands occur locally, from a few centimetres to several decimetres thick.

Local silt deposits may occur in areas N-8 and N-10 to 13. The same applies to the planned submarine cable systems in this area. Local deposits of clays and silts can be expected more frequently in the first 4 to 5 m for submarine cable systems in the Elbe-Urstromtal Valley area.

The sediment composition in the areas and submarine cable systems between the traffic separation areas consists of the upper seabed, which is generally a loose top layer of partly clayey silty fine and medium sands, about 1–2 m thick. Locally, this top layer may also be missing. Beneath this top layer are fine and medium sands, occasionally several metres thick and predominantly medium-dense to dense. Clays and silts, some with a firm consistency, were described locally in the area of the power transmission routes to gate N-II (Norderney) and, above all, to gate N-I (Ems). Rocks can also be expected in the area of the routes to gate N-I due to the proximity to the Borkum Reef Ground.

In the eastern planning area, the near-surface subsoil in the areas and in the vicinity of the submarine cable routes also consists predominantly of loose to dense fine and medium sands. The fine grain content is usually below 5%. Coarse sand, gravel and rocks can occur locally to varying degrees, both in the areas and in the vicinity of the submarine cable systems. This is particularly true of the submarine cable systems to the gate east of area N-4 and the area of the approved "COBRAcable" transboundary submarine cable system.

2.2.6 Distribution of pollutants in the sediment

2.2.6.1 Metals

The seabed is the most important sink for trace metals in the marine ecosystem. However, it may also act as a source of pollution on a regional level due to resuspension of historical deposits of highly contaminated material. The absolute metal content in the sediment is strongly dominated by the regional grain size distribution. Higher levels are observed in regions with a high mud content than is the case in sandy regions. This is because the fine sediment content has a greater affinity for the adsorption of metals. Metals accumulate in the fine-grain fraction for the most part.

In most regions of the German EEZ, the elements copper, cadmium and nickel in particular move at low concentrations or in the range of background concentrations. Elevated levels of all heavy metals are detected near the coast, although this is less pronounced along the East Frisian Islands than along the North Frisian coast. These very distinct gradients, with elevated levels near the coast and very low levels in the central North Sea, indicate that freshwater inflows play a dominant role as a source of metal pollution. That said, there are also clearly elevated levels of lead in particular in the fine-grain fraction in the central North Sea. These are even higher than the values measured at coastal stations. The spatial distribution of nickel levels in the fine-grain fraction of the surface sediment, on the other hand, is characterised only by very weakly pronounced gradients. The spatial structure permits few conclusions to be drawn with regard to the most significant contamination. Heavy metal contamination in the surface sediment of the EEZ has either been declining overall over the last 30 years (Cd, Cu, Hg) or exhibits no clear trend (Ni, Pb, Zn).

2.2.6.2 Organic substances

Most of the organic pollutants are of anthropogenic origin. About 2,000 substances, mainly produced industrially, are currently considered environmentally relevant (pollutants) because they are poisonous (toxic) or constant (persistent) in the environment and/or can accumulate in the food chain (bioaccumulative). Their properties may vary widely, so their distribution in the marine environment is dependent on a range of factors. Besides input sources, input quantities and input paths (directly via rivers, diffusely via the atmosphere), the physical and chemical properties of the pollutants and the dynamic-thermodynamic state of the sea are relevant for dispersion, mixing and distribution processes. For these reasons, the various organic pollutants in the sea are distributed unevenly and differently and occur in very different concentrations.

The Federal Maritime and Hydrographic Agency determines up to 120 different pollutants in seawater, suspended matter and sediments during its monitoring cruises. The Elbe is the main input source of most pollutants in the German Bight. The Elbe plume off the North Frisian coast therefore generally contains the highest concentrations of pollutants, and the level generally decreases from the coast towards the open sea. The gradients for non-polar substances are particularly strong, as these substances are predominantly adsorbed on suspended matter and removed from the water phase by sedimentation. Concentrations of non-polar pollutants are therefore usually very low outside coastal regions rich in suspended matter. However, many of these substances are also released into the sea by atmospheric deposition or have direct sources in the sea (e.g. PAHs (polycyclic aromatic hydrocarbons) – inputs from the oil and gas industry and shipping), and so sources far from land must also be taken into account in the distribution of these substances.

According to current knowledge, the observed concentrations of most pollutants in seawater do not pose any immediate threat to the marine ecosystem. One exception is the pollution caused by tributyltin hydride (TBT), which used to be used in ship paints. The concentration of this near the coast reaches the effective biological threshold in some cases. Furthermore, acute oil spills (shipping, offshore oil production) can cause massive harm to seabirds and seals.

2.2.6.3 Radioactive substances (radionuclides)

Radioactive contamination of the North Sea through discharges from nuclear fuel reprocessing plants has been determined for decades. As these discharges are very low nowadays, radioactive contamination of the North Sea poses no threat to mankind and nature according to current knowledge.

2.2.6.4 Inherited waste

Remnants of ammunition are possible causes of contaminated sites in the North Sea EEZ. A federal-state working group published a basic report on ammunition pollution in German marine waters in 2011, and this is updated annually. According to official estimates, 1.6 million tonnes of old ammunition and a wide variety of explosive ordnances are deposited on the beds of the North Sea and Baltic Sea. A significant proportion of these remnants of munitions date back to the Second World War. Even after the end of the war, large quantities of ammunition were dumped in the North Sea and Baltic Sea for the purposes of disarming Germany. According to current knowledge, explosive ordnance contamination in the German North Sea is estimated at levels of up to 1.3 million tonnes. Overall, there is insufficient data to refer to, so it is necessary to assume that explosive ordnances are also to be expected in the area of the German EEZ (e.g. remnants of mine barrages and combat operations). The locations of the known munitions dumping areas can be found in the official nautical charts and the report from 2011 (with additional information on areas suspected of being contaminated with munitions).

The reports by the federal-state working group are available from www.munition-im-meer.de.

2.2.7 Status estimation

2.2.7.1 Natural factors

Climate change and sea level rise: the North Sea region has experienced a dramatic change in climate over the last 11,800 years, linked to a profound change in land-sea distribution due to the global sea level rise of 130 metres. The North Sea reached its current level over a period of about 2,000 years. Sea levels off the German North Sea coast rose by 10 to 20 cm in the 20th century. Storms cause changes to the seabed. All sediment dynamic processes can be traced back to meteorological and climatic processes, which are essentially controlled by the weather in the North Atlantic.

2.2.7.2 Anthropogenic factors

Fishing: bottom trawlers in the North Sea use trawl boards and beam trawls. Trawl boards are used mainly in the northern part of the North Sea and are pulled diagonally across the seabed. Beam trawls, on the other hand, have been used in the southern part of the North Sea since the 1930s. There has been a sharp increase in beam trawling since the 1960s, although this has declined slightly over the past decade as a result of catch regulations and the decline in fish stocks. The beam heads of the beam trawls leave tracks 30 to 50 cm wide. In particular, their tickler chains or chain nets have more of an effect on the bed than trawl boards. The bottom trawls in the sediment create specific furrows, which can be a few millimetres to 8 cm deep on till and sandy soils and up to 30 cm deep in soft mud. The results from EU's TRAPESE project show that, at most, the upper 10 cm of the seabed is churned up and whirled up regularly (PASCHEN et al. 2000).

Submarine cables (telecommunications, power transmission): the jetting process when laying cables in the seabed results in turbidity of the water column as a result of sediment agitation, although this is distributed over a larger area by the influence of tidal currents. The suspension content decreases again to the natural background values due to dilution effects and sedimentation of the whirled-up sediment particles. The sediment dynamic processes generally lead to complete levelling of the traces left behind after laying, especially after periods of bad weather. Rock fills of a locally limited, non-native hard substrate are applied in the area of cable crossings.

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

<u>Status estimation</u>

The assessment of the state of the seabed with regard to sedimentology and geomorphology is limited to the areas, sites and routes defined in the Site Development Plan. It has been compiled for the aspects "Rareness and vulnerability", "Diversity and uniqueness" and "Naturalness" in Table 1.

With regard to pollution, it should essentially be noted that the sediment in the study area is only slightly polluted by metals and organic pollutants and their concentration decreases more or less rapidly from the coast towards the open sea.

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

Aspect: Rareness and vulnerability

Criterion	Category		Estimation
The portion of the sediments on the seabed and distribution of the morphological form inventory.	High	Sediment types and soil forms occur exclusively in the area being considered.	Low
	Medium	Sediment types and soil forms are common in the German Bight (including Dogger Bank).	
	Low	Sediment types and soil forms can be found throughout the North Sea.	
Aspect: Diversity and uniqueness			
Criterion	Category		Estimation
Heterogeneity of the sediments on the seabed and development of the morphological form inventory.	High	Heterogeneous sediment distribution and pronounced morphological conditions.	Medium
	Medium	Heterogeneous sediment distribution and no pronounced soil forms or homogeneous sediment distribution and pronounced soil forms.	
	Low	Homogeneous sediment distribution and unstructured seabed.	
Aspect: Naturalness			
Criterion	Category		Estimation
Extent of initial anthropogenic contamination of sediments on the seabed and of the morphological form inventory.	High	Almost no change due to anthropogenic activities.	Medium
	Medium	Change due to anthropogenic activities with no loss of ecological function.	
	Low	Change due to anthropogenic activities with loss of ecological function.	

2.3 Water

The North Sea is a relatively shallow shelf sea with a wide opening to the North Atlantic 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. To the southwest, the Atlantic has less influence on the North Sea because of the shallow English Channel and the narrow Straits of Dover. The Baltic Sea is connected to the Kattegat/Skagerrak and the North Sea by the Great and Small Belt and the Sound.

2.3.1 Currents

The currents in the North Sea consist of an overlapping of half-day tidal currents with wind- and density-driven currents. In the North Sea, an extensive cyclonic (anticlockwise) circulation generally predominates. This is associated with a strong inflow of Atlantic water on the northwest edge, and with an outflow into the Atlantic via the Norwegian Channel. The strength of the North Sea circulation depends on the prevailing barometric pressure distribution over the North Atlantic, which is parameterised through the North Atlantic Oscillation (NAO) Index, the standardised air pressure difference between Iceland and the Azores.

Based on an analysis of all current measurements performed by the Federal Maritime and Hydrographic Agency and the German Hydrographic Institute (DHI) between 1957 and 2001 (KLEIN 2002), the mean values of the current velocity (scalar mean including tidal current) and the residual current velocities (vector mean) near the surface (at a water depth of 3 – 12 m) and near the seabed (0 – 5 m to the seabed) were determined (Table 6: Mean current velocities, residual and tidal currents in the German Bight.) for various areas in the German Bight. All time series at least 10 days long and water depths of more than 10 m were considered in this analysis. The objective of the analysis was to estimate the conditions in the open sea. The mean values are shown in Table 2. The tidal currents were determined by the connection to the Helgoland tide gauge, i.e. the currents measured are related to the tidal ranges and high tide times observed there (KLEIN & MITTELSTAEDT 2001).

Table 6: Mean current velocities, residual and tidal currents in the German Bight.

	Proximity to surface (3 – 12 m)	**Seabed level (0 – 5 m seabed distance)**
Mean amount	25 – 56 cm/s	16 – 42 cm/s
Vector mean (residual current)	1 – 6 cm/s	1 – 3 cm/s
Tidal current	36 – 86 cm/s	26 – 73 cm/s

Figure 10 shows the current conditions in the near-surface layer (measuring depth 3 – 12 m) for different areas in the German Bight. The values in area GB3 correspond to the (geological) subarea "Borkum and Norderney Reef Ground", while GB2 corresponds to the subarea "Northern Helgoland" and GB1 corresponds to the subarea "Elbe-Urstromtal Valley and western plains".

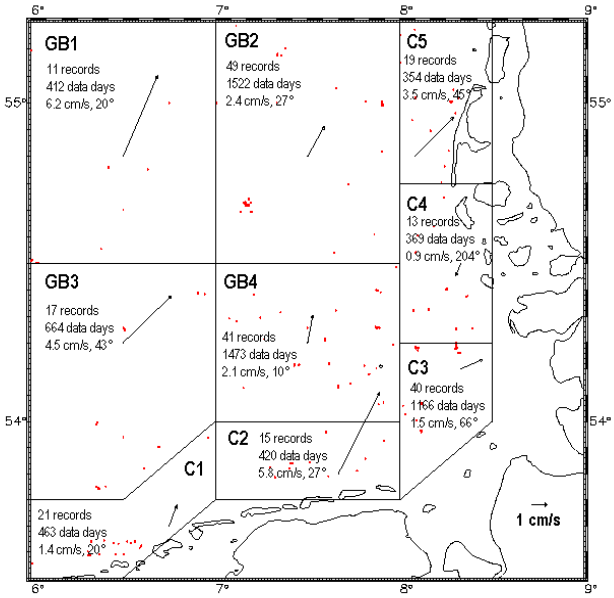


Figure 10: Vector mean of the current in the near-surface layer (measuring depth 3 to 12 m). The measuring positions are marked with red dots (Federal Maritime and Hydrographic Agency 2002).

2.3.2 Swell

In heavy seas, a distinction is made between the waves generated by the local wind, known as wind sea, and swell. Swell refers to waves that have left their area of origin and enter the sea area being considered. The swell entering the southern part of the North Sea is caused by storms in the North Atlantic or the northern North Sea. Swell has a longer period than wind sea. The height of the wind sea is dependent on the wind speed and the time over which the wind acts on the surface of the water (duration), and also on the fetch, i.e. the distance over which the wind acts. For example, the fetch in the German Bight is significantly shorter with easterly and southerly winds than with northerly and westerly winds. The significant or characteristic wave height, i.e. the mean wave height within the upper third of the wave height distribution, defines the size of the wind sea.

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

2.3.3 Temperature, salinity and seasonal stratification

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

The time series of the annual mean of the spatial mean temperature of the entire North Sea based on the temperature charts published weekly by the Federal Maritime and Hydrographic Agency since 1968 shows that the course of the SST is not characterised by the linear trend, but by regime changes between warmer and colder phases (see also Figs. 3–28 in Federal Maritime and Hydrographic Agency 2005). The extreme warm regime of the first decade of the new millennium, in which the annual mean of the North Sea SST fluctuated around an average level of 10.8 °C, ended with the cold winter of 2010 (Figure 11). After four significantly cooler years, the North Sea SST reached the highest annual mean to date, 11.4 °C, in 2014.

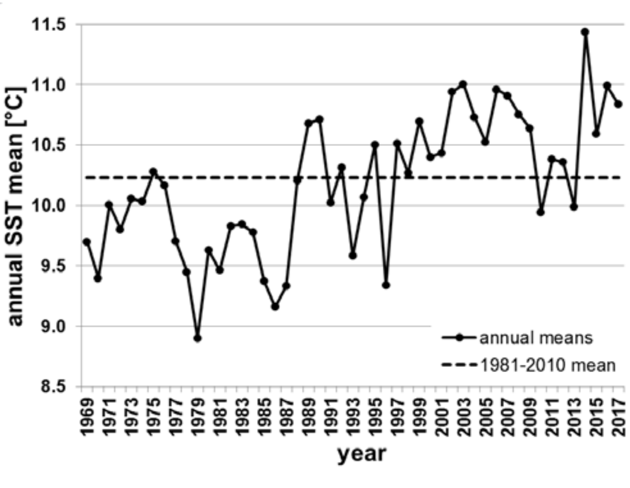


Figure 11: Annual mean North Sea surface temperature for 1969–2017

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

Unlike with temperature, there is no clearly pronounced annual course for salinity. Stable salinity stratifications occur in the North Sea, in the estuaries of the major rivers and around the area of the Baltic outflow current. The freshwater discharge of the major rivers within the estuaries mixes with the coastal water at shallow depths due to tidal turbulence, but it stratifies over the North Sea water at greater depths in the German Bight. The intensity of the stratification varies depending on the annual courses of the river inputs, which in turn exhibit significant interannual variability due to factors such as high meltwater runoff in spring after harsh, snowy winters. For example, the salinity at Helgoland Roadstead is negatively correlated with the discharge volume of the Elbe, which shows that the freshwater inputs result in significant reduction of near-surface salinity in close proximity to the coast (LOEWE et al. 2013); the Elbe having the greatest influence on salinity in the German Bight, with a discharge rate of 21.9 km³/year.

The salinity measurements of Helgoland Roadstead have been available since 1873, along with – since 1980 – data at the positions of the former lightships, which were later replaced at least partly by automated measuring systems. The changes of lightship positions and methodological problems, including in the case of measurements near Helgoland, led to fractures and uncertainties in the long time series and made it more difficult to estimate trends reliably (HEYEN & DIPPNER 1998). No long-term trend in the annual mean of the surface salinity at Helgoland is discernible for the period 1950–2014. This also applies to the annual discharge rates of the Elbe. At present, there is still a great deal of variation in the projections for the future development of salinity in the German EEZ with regard to temporal development and spatial patterns. More recent projections indicate a decrease in salinity of between 0.2 and 0.7 PSU by the end of the century (KLEIN et al. 2018).

2.3.4 Ice conditions

In the open German Bight, the heat reserve of the relatively salty North Sea water in early winter is often still so great that ice is able to form only on very rare occasions. The open sea area off the North and East Frisian Islands remains ice-free for two-thirds of all winters. On a long-term average, the edge of the ice extends to directly behind the islands and into the outer estuaries of the Elbe and Weser rivers. In normal winters, ice occurs on 17 to 23 days in the protected inner fairways of the North Frisian Wadden region; and only on two to five days in the open fairways, similar to the East Frisian Wadden region.

In ice-rich and very ice-rich winters, on the other hand, ice occurs on 54 to 64 days on average in the protected inner fairways of the North Frisian Wadden region; and on 31 to 42 days in the open fairways, similar to the East Frisian Wadden region. Solid ice mainly forms in the inner Wadden regions. Ice floes and slush form for the most part in the outer Wadden regions, and these are kept moving by wind and tidal effects. Further information can be found in the Climatological Ice Atlas 1991–2010 for the German Bight (SCHMELZER et al. 2015).

2.3.5 Fronts

Fronts in the sea are high-energy mesoscale structures (ranging in size from a few tens to a few hundreds of kilometres) that have a major impact on biology, ecology and the local movement dynamics of water, and on the climate as well due to their ability to transport CO_2 to greater depths. In the coastal areas of the North Sea, in particular off the coasts of Germany, the Netherlands and the UK, what are known as the river plume fronts with strong horizontal salt and suspended matter gradients lie between the freshwater inputs of the major continental rivers and the continental coastal waters of the North Sea. These fronts are not static structures, but consist of a system of smaller fronts and vortices with typical spatial scales between 5 and 20 km. This system is subject to major temporal variability, with time scales from 1 to about 10 days. Frontal structures are continuously dissolved and formed as a function of meteorological conditions, the discharge rates of the Elbe and Weser rivers and the circulation conditions in the German Bight. Only in extremely calm weather conditions can discrete frontal structures be observed over longer periods of time. During the seasonal stratification period (from about the end of March to September), the tidal mixing fronts which mark the transition area between the thermally stratified deep waters of the open North Sea and the shallower area vertically intermixed due to wind and tidal friction are located approximately in the area of the 30 m isobath. These fronts are relatively stationary due to their dependence on topography (OTTO et al. 1990). KIRCHES et al. (2013a-c) analysed satellite-based remote sensing data from 1990 to 2011 and developed a climatology for SST, chlorophyll, yellow and suspended matter fronts in the North Sea. This shows that fronts occur all year round in the North Sea, with the strength of the spatial gradient generally increasing towards the coast.

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

2.3.6 Suspended matter and turbidity

The term "suspended matter" refers to all particles with a diameter >0.4 µm that are suspended in seawater. Suspended matter consists of mineral and/or organic material. The organic suspended matter content is greatly dependent on the season. The highest values occur during plankton blooms in early summer. In stormy weather conditions and the resulting high waves, the suspended matter content in the entire water column rises sharply due to the whirling-up of silty-sandy bottom sediments. The swell has the greatest impact. When hurricanes cause damage on passing through the German Bight, increases in the suspended matter content of up to ten times the normal values are easily possible. It is not possible to take water samples in extreme storm conditions: corresponding estimates are therefore derived from the records of anchored turbidity measuring instruments. A pronounced half-day tidal signal is always found if the temporal variability of the suspended matter content at a fixed position is considered. Ebb and flow currents transport the water in the German Bight about 10 nautical miles away from or towards the coast, on average
(Figure 5). Accordingly, the high Suspended Particulate Matter (SPM) content near the coast is also transported 'back and forth' and causes the strong local fluctuations. Further variabilities in the SPM are caused by material transport (advection) from rivers such as the Elbe and Weser and from the southeast coast of England.

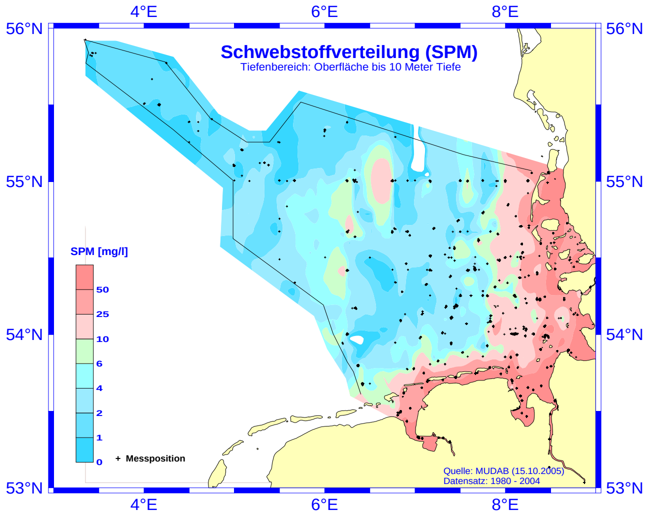


Figure 12: Mean Suspended Particulate Matter (SPM) for the German North Sea.

Figure 12 shows the mean suspended matter distribution for the German Bight. All SPM values stored in the MUDAB marine environment database as of 15 October 2005 form the basis for the illustration. The dataset was reduced to the range "Surface to 10-metre depth" and values ≤ 150 mg/l. The underlying measured values were only obtained in weather conditions in which research vessels are still able to work. Difficult weather conditions are therefore not reflected in the mean values shown here. In Figure 12, mean values around 50 mg/l and extreme values >150 mg/l were measured in the mudflats landward of the East and North Frisian Islands and in the large river estuaries. Further seawards, the values quickly decrease to a range of between 1 and 4 mg/l. Slightly east of 6° E, there is an area with an increased suspended matter content. The lowest mean SPM values around 1.5 mg/l are found on the northwestern fringes of the EEZ and above the sandy areas between the Borkum Reef Ground and the Elbe-Urstromtal Valley.

2.3.7 Status assessment with regard to nutrient and pollutant distribution

2.3.7.1 Nutrients

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

The Federal Maritime and Hydrographic Agency conducts several monitoring cruises per year in order to monitor nutrient and oxygen levels in the German Bight. Nutrient concentrations have a typical annual course, with high concentrations in winter and low concentrations in the summer months. All nutrients have similar distribution structures. A gradual decrease in concentration can be observed from the river estuary to the open sea. The highest concentrations are measured in the Elbe inflow area and the coastal regions. The nutrient input through the Elbe can be seen clearly here (Figure 13).

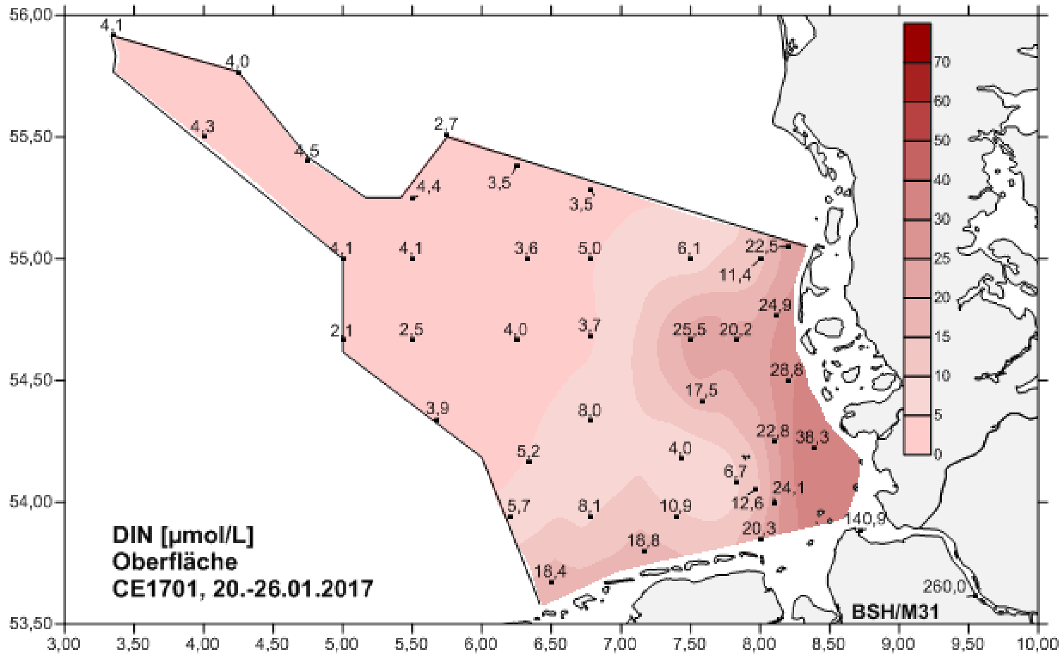


Figure 13: Distribution pattern of soluble inorganic nitrogen compounds (DIN).

Measures such as the expansion of sewage treatment plants, the introduction of phosphate-free detergents, etc. have reduced nutrient inputs into the North Sea by around 50% since 1983 and phosphorus inputs by as much as 65% (UBA 2017). Nevertheless, according to the Common Procedure for the Identification of the Eutrophication Status of the OSPAR Maritime Area (the "Common Procedure"), coastal waters and large parts of the German Exclusive Economic Zone (EEZ) (a total of 55% of German North Sea waters) are classified as eutrophic in the assessment period 2006–2014 (Brockmann et al. 2017). Only in the outer German Bight

(Entenschnabel) could a good environmental status be determined (6% of German North Sea waters). This assessment serves as a basis for subsequent assessment in accordance with the EU-MSFD, so good environmental status with regard to Descriptor 5 (eutrophication) is also missed in accordance with the MSFD (BMU 2018).

2.3.7.2 Metals

Metals occur naturally in the environment. So under no circumstances is evidence of metals in the environment necessarily to be regarded as pollution. Besides naturally occurring element concentrations, human activities currently mobilise, transport, partially transform and re-enrich considerable additional quantities of individual elements in the environment. In general, metal levels in 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. The runoff of contaminated freshwater masses via the continental river systems, the transport of pollutants via the atmosphere, and interrelationship with sediment are essential sources for the metal signal caused by human activity in marine ecosystems. Further inputs are due to offshore activities such as natural resource exploration and extraction, as well as the introduction of dredged material.

Metals are dissolved in the water body and bound to suspended matter. The suspended matter content in the water column decreases further away from the coast, i.e. with increasing salinity levels. Thus, the proportion of surfaces available for adsorption processes decreases and a proportionally increasing percentage of the metals remains in solution.

In a similar way to the nutrients, some metals in the dissolved fraction show seasonal periodic fluctuations in concentration. This seasonal profile roughly corresponds to the biological growth and remineralisation cycle, as is also the case for nutrient content dissolved in seawater.

Above all, mostly dissolved elements (Cu, Ni, Cd), but also mercury, form a distinct gradient that decreases from the coast towards the open sea. The current generally transports the water masses from the west into the German Bight and then to the north, heading out of it. Correspondingly, the runoff plume of the Elbe, starting from the estuary area, is clearly pronounced towards the north.

2.3.7.3 Organic substances

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

New analytical methods have been used in recent years 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 classic pollutants.

According to current knowledge, the observed concentrations of most pollutants in seawater do not pose any immediate threat to the marine ecosystem. One exception is the pollution caused by tributyltin (TBT), which used to be used in ship paints. The concentration of this near the coast reaches the effective biological threshold in some cases. Furthermore, seabirds and seals may be harmed by oil films floating on the surface of the water as a result of acute oil spills. Toxicity assessment of individual pollutants is not sufficient in the ecotoxicological assessment; rather, the cumulative effect of the large number of pollutants present – which may be enhanced by synergy effects – must be considered.

2.3.7.4 Radioactive substances (radionuclides)

Radioactive contamination of the North Sea through discharges from nuclear fuel reprocessing plants has been determined for decades. As these discharges are very low nowadays, radioactive contamination of the water body of the North Sea poses no threat to mankind and nature according to current knowledge.

2.4 Plankton

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

2.4.1 Data availability

There are few monitoring programmes for plankton. Previous findings on the spatial and temporal variability of phytoplankton and zooplankton come from research programmes, a small number of long-term studies, and ecosystem modelling. Remote sensing has also contributed significantly to improvement of the data in recent years. Since 1932, the Continuous Plankton Recorder (CPR) has been providing a valuable long-term series of data from the North-East Atlantic and North Sea area (REID et al. 1990, BEAUGRAND et al. 2003). The images from the CPR have identified about 450 different phytoplankton and zooplankton taxa: more than 100 phytoplankton species have been identified in the North Sea (EDWARDS et al. 2005).

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

The zooplankton of the Helgoland Roadstead has also been investigated continuously and systematically since 1975 (GREVE et al. 2004).

There is no such long-term series in the German EEZ. Plankton (phytoplankton and mesozooplankton) were only investigated by the Leibniz Institute for Baltic Sea Research Warnemünde (IOW) on behalf of the Federal Maritime and Hydrographic Agency at 12 selected stations in the German EEZ as part of the biological monitoring initiative between 2008 and 2011. Sampling took place five times a year in parallel with nutrient sampling (WASMUND et al. 2012). For this reason, the description of the current situation will be limited to the investigations at the Helgoland Roadstead station and indications from the IOW's four years of investigations. It should be noted that Helgoland is hydrographic and not representative of the EEZ with regard to phytoplankton association. Zooplankton samples were taken and analysed at the FINO1 research platform in the EEZ area between March 2003 and December 2004 (OREJAS et al.

2005). The hydrographic conditions in this part of the EEZ vary considerably from those of the Helgoland Roadstead, in particular due to the depth of the water and the prevailing current. However, a strongly pronounced variability in succession, as observed at the Helgoland Roadstead, has also been documented in this area.

2.4.2 Spatial distribution and temporal variability of phytoplankton

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

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

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

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

There are fixed patterns of phytoplankton growth in the German Bight over the course of the year. Spring growth and thus algal bloom (increase in algae mass) only begin spatially in the areas away from the coast, i.e. in the outer area of the German EEZ. Different diatom species provide for the spring algal bloom from year to year. *Thalassiosira rotula* forms spring algal blooms particularly frequently (VAN BEUSEKOM et al. 2003).

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

The spatial distribution of phytoplankton is primarily dependent on the physical processes in the pelagic zone. Hydrographic conditions – in particular temperature, salinity, light, current, wind, turbidity, fronts and tides – influence the occurrence and biodiversity of phytoplankton. The North Sea can be roughly divided into two fundamentally different areas for the occurrence of plankton: the area where the water body is intermixed throughout the year, and the area with strong stratification (vertical layering) of the water body. As a rule, these also have different nutrient concentrations. The points at which intermixed and stratified water masses meet are known as oceanographic fronts (see chapter 2.3.5). These largely determine the occurrence of phytoplankton. Phytoplankton are abundant in stratified water bodies near the thermocline (the layer boundary between overlapping water masses at different temperatures).

In the German Bight, the geographical positions of fronts change depending on the weather conditions, freshwater input from rivers, tides and wind-induced currents. Ideally, however, they occur in the inner areas of the German Bight. In general, the nutrient levels in the area of 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 area of the Schleswig-Holstein coastal waters off Sylt. This is also reflected in phytoplankton growth and chlorophyll$_a$ concentrations (VAN BEUSEKOM et al. 2005).

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

2.4.3 Spatial distribution and temporal variability of zooplankton

Zooplankton include all tiny marine animals floating in or migrating into the water column. Zooplankton play a key role in the marine ecosystem as the lowest secondary producer in the marine food chain, acting as a food source for carnivorous zooplankton species, fish, marine mammals and seabirds.

Zooplankton also have a special significance as a primary consumer (grazer) of phytoplankton. Grazing can stop the algal bloom and regulate the degradation processes of the microbial cycle by consuming the cells.

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

Zooplankton are subdivided into the following groups according to the life strategies of the organisms:

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

fish larvae are abundant in merozooplankton during the reproduction period.

The transport and distribution of larvae are of particular importance for the spatial occurrence and population development of nektonic and benthic species. The distribution of larvae is determined by both the movements of the water masses themselves and the endogenous or species-specific characteristics of the zooplankton. Environmental factors that are capable of influencing the distribution, metamorphosis and colonisation of larvae are: sediment type and structure, meteorological and hydrographic conditions, light, and chemical substances released into the water by adult individuals of the species.

It is difficult to characterise habitat types due to the occurrence of zooplankton. As already explained for phytoplankton, water masses actually form the habitat of zooplankton. In 2010, a total of 157 zooplankton taxa were determined within the framework of biological monitoring; the Arthropoda being the most frequent group with 80 taxa, followed by the Cnidaria with 27 taxa, the Polychaeta with 15 and Echinodermata larvae with 9 taxa. The total number exceeded the figure for 2009 by 14 taxa, and the 2008 figure by 40 taxa. Less diversity was observed in the entire region off the North Frisian Islands (stations HELGO, AMRU2 and SYLT1, Fig. 14). This observation goes hand-in-hand with the large-scale water transport off the coast in the direction of Jutland. In 2008, this zone was characterised by a "muzzle 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 further away from the station at Helgoland, which is nearest to the mouth of the Elbe, towards the central North Sea. This was already found in 2008, the first year of the report. This result was supported by the then changing copepod composition, according to which the proportion of marine genera increased from 20% to over 80% as the distance to the coast increased (WASMUND et al. 2009 and 2011).

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

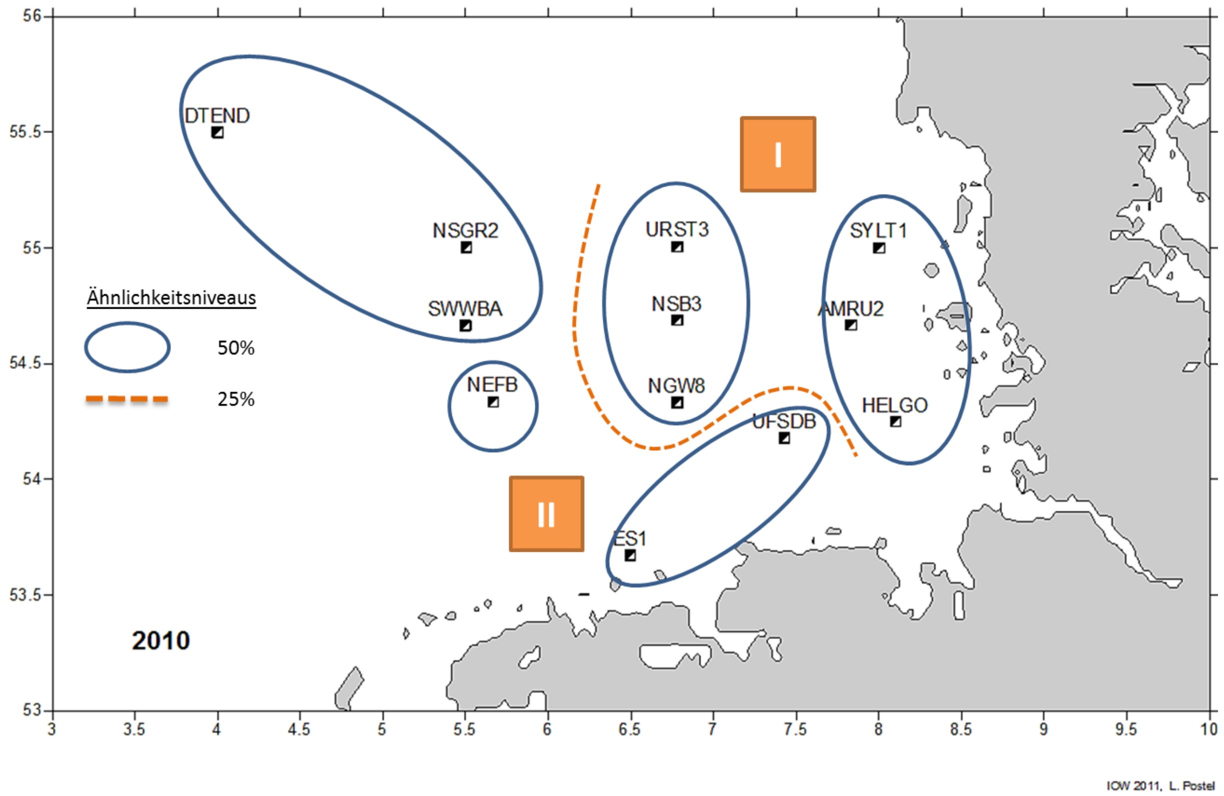


Figure 14: Spatial distribution of mesozooplankton communities according to cluster analysis based on abundances of all taxa and their developmental stages in the German EEZ, 2010 (WASMUND et al. 2011).

2.4.4 Status assessment of plankton

Overall, taking into account all available long-term data (CPR, Helgoland Roadstead) since the late 1980s and in the 1990s, changes can be observed in both the phytoplankton and zooplankton of the North Sea. The slowly progressing changes affect species composition 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 Roadstead thus shows a significant increase in biomass since records began. This increasing trend in biomass seems to be linked to the development of flagellates. In the area of the German Bight, a decline in diatoms in favour of small flagellates has been observed since the early 1970s (HAGMEIER & BAUERNFEIND 1990, VON WESTERNHAGEN & DETHLEFSEN, 2003). The changes in the phytoplankton also involve weakening of the late summer diatom bloom, extension of the growth phase and the occurrence of algal blooms of non-native species.

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

Increasingly, non-native species are also affecting succession. The number of alien species spreading in the North Sea as a result of anthropogenic influences has increased significantly in recent years. Alien species are imported via ballast water from ships and shellfish aquaculture.

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

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

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

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

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

There has also been evidence of a gradual change in **zooplankton** since the early 1990s. 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 coldwater holoplankton species has decreased considerably. In contrast, meroplankton has increased (LINDLEY & BATTEN 2002). The proportion of echinoderm larvae has increased noticeably. This is mainly associated with the spread of the opportunistic species *Amphiura filiformis* (KRÖNCKE et al. 1998).

The seasonal development and succession of zooplankton in the German Bight correlate mainly with changes in water temperature. However, the changes in seasonal development vary according to the species.

Overall, abundance maxima of various key species occur up to 11 weeks earlier in warm years than is 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 change has in particular affected the range limits of species and groups in the North Sea marine ecosystem. Zooplankton associations of warmwater species in the North-East Atlantic, for example, have shifted their distribution almost 1,000 km to the north. In contrast, the areas of coldwater associations have decreased in size. Moreover, climate change has an impact on the seasonal occurrence of abundance maxima of different groups. For example, *Calanus finmarchicus* reaches its maximum abundance 11 days earlier, while its main food, the diatom species *Rhizosolenia alata*, reaches its maximum concentration 33 days earlier and the dinoflagellate species *Ceratium tripos* reaches its maximum concentration 27 days earlier. This delayed population development can impact on the entire marine food chain. EDWARDS & RICHARDSON (2004) even suspect a particular threat to temperate marine ecosystems through change or temporal offset in the development of different groups.

The threat arises from the direct dependence of the reproductive success of secondary consumers (fish, marine mammals, seabirds) on plankton (nutritional basis). Evaluations of long-term data for the period 1958 to 2002 for 66 marine taxa have confirmed that marine planktonic associations react to climate change. However, the reactions are very different with regard to association or group and seasonality.

2.5 Biotopes

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

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

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

2.5.1 Data availability

The distribution of sandbanks and reefs in the German North Sea EEZ is widely known. However, there is currently no area-wide mapping of the biotope type distribution for the North Sea EEZ, so the occurrence of other marine biotopes can currently be shown only inadequately. A spatial distribution pattern of superior biotopes according to FINCK et al. (2017) was developed based on information from the BfN database LANIS Habitat Mare (Figure 15). Certainly, areas of marine biotope types that cannot be sufficiently scientifically defined can be represented on this basis. Detailed and extensive mapping of marine biotopes in the EEZ is currently being developed as part of R&D projects ongoing at the Federal Agency for Nature Conservation.

Detailed surveys of the biotopes in the vicinity of the planned cable routes were carried out as part of the procedures for the transboundary submarine cable systems COBRAcable and NordLink, particularly in the area of the Borkum Reef Ground and the Sylt Outer Reef. These findings on the occurrence of protected biotope types are currently being used in ongoing procedures for route planning that is as environmentally friendly as possible. In addition to information from environmental impact studies, current findings on biotopes from wind farm projects are available for the designated areas and sites (BioConsult 2016b, 2017, 2018; IBL 2016; PGU 2012a, b, 2015; IfaÖ 2015 a, b, 2016).

From a nature conservation perspective, natural biotope complexes ("mosaics") are of particular importance, such as the residual sediment deposits which occur mainly on the eastern slope of the Elbe-Urstromtal Valley (Sylt Outer Reef) and the Borkum Reef Ground. Associated with these biotopes are gravel fields, coarse, medium and fine sand areas, and even silty-sandy substrates in small hollows on occasions (usually only a thin layer of silt which is remobilised again depending on the hydrodynamic conditions). This structural diversity, together with the protection afforded by the rocks, results in great diversity of species overall.

Large areas of sand (especially fine and medium sands) are regularly relocated by waves in the shallower sea territories (less than about 30 m), so the fauna living there can be very variable (Rachor & Gerlach 1978). Small rock fields can be so strongly influenced by sand movements (over-sanding, exposure) that long-lived reef communities cannot survive.

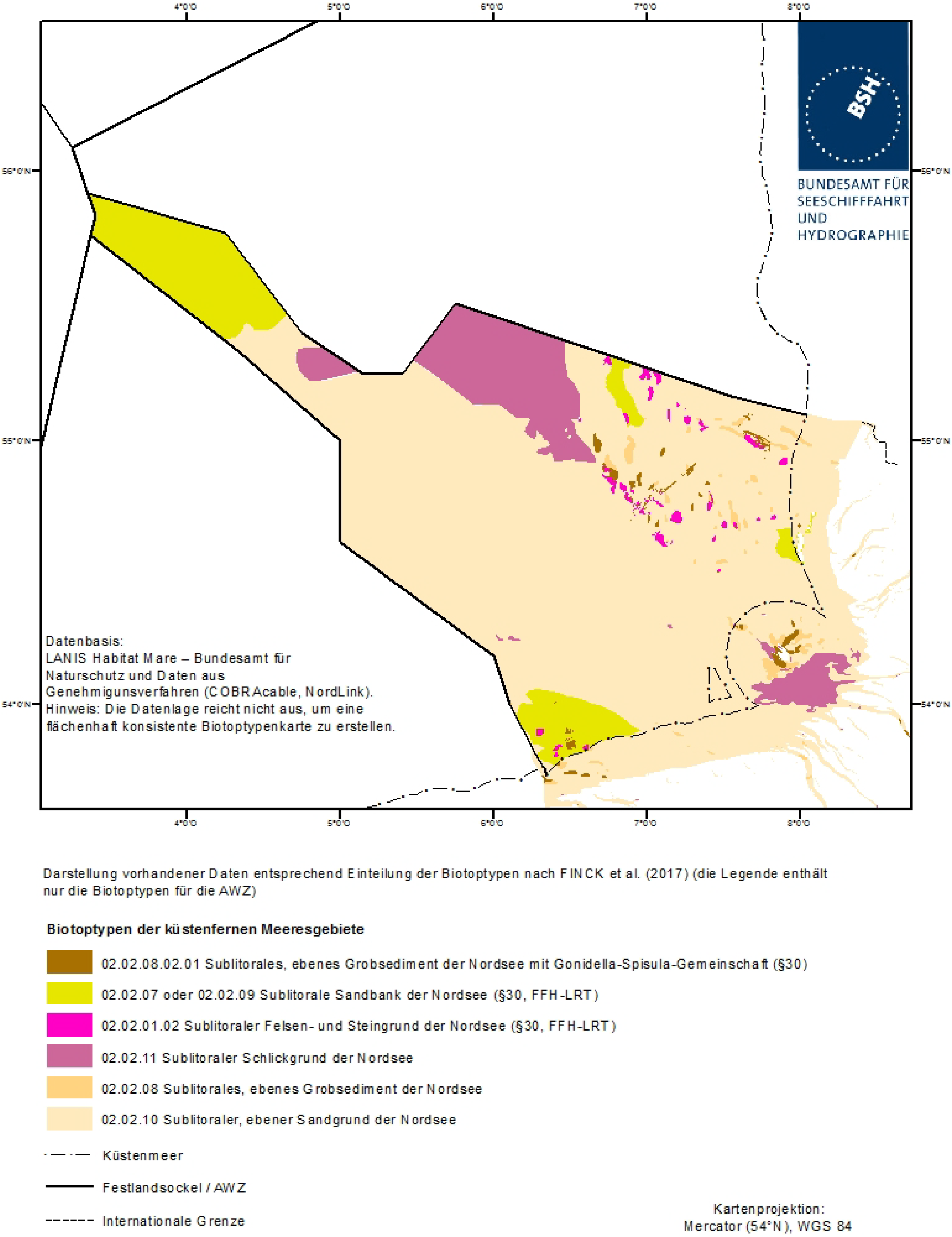


Figure 15: Map of German North Sea biotopes that can be defined based on existing data.

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

In the German North Sea EEZ, biotopes of type 1110 "Sandbanks" and 1170 "Reefs" to be protected under EU law (Habitats Directive, Annex I) have been identified to date. Reefs and sandbanks are habitat types and at the same time protected according to section 30 of the Federal Nature Conservation Act.

A number of marine biotopes are subject to direct federal protection pursuant to section 30 of the Federal Nature Conservation Act. Section 30 subsection 2 of the Federal Nature Conservation Act essentially prohibits acts that may cause destruction or other significant impairment of the listed biotopes. No designation of protected areas is required for this purpose. This protection was extended to the EEZ with the 2010 amendment of the Federal Nature Conservation Act. In the North Sea EEZ, the following four marine and coastal biotopes are subject to statutory biotope protection pursuant to section 30 subsection 2 no. 6 of the Federal Nature Conservation Act: Reefs (also a habitat type), sublittoral sandbanks (also a habitat type), species-rich gravel, coarse sand and shell layers, as well as silty areas with burrowing megafauna. The protected biotope type "Seagrass meadows and other marine macrophyte populations" does not occur in the North Sea EEZ.

2.5.2.1 Reefs

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

From the BfN's standpoint, such reefs and reef-like structures are found in some areas of the North Sea EEZ. Areas in the vicinity of the Borkum Reef Ground, in the area of the eastern slope of the Elbe-Urstromtal Valley and Helgoland Steingrund should be noted in particular here. However, there are currently no mapping instructions for the habitat type "Reefs".

There are relevant findings about the occurrence of the habitat type "Reefs" in the area of the planned COBRAcable route for the Sylt Outer Reef and the Borkum Reef Ground. The corresponding mapping instructions of the BfN have to be consulted for recording of the biotope type "reefs" in the German EEZ (BfN 2018).

2.5.2.2 Sandbanks

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

In the German North Sea EEZ, several sandbanks worthy of protection were identified from a nature conservation perspective. Large sandbanks are the Dogger Bank and the somewhat smaller Amrumbank. In the opinion of nature conservation experts, the Borkum Reef Ground is one example of a sandbank with rock fields or stony and gravelly areas as reef-like structures. In several BfN study areas, typical sandy soil communities were found which develop depending on the sediment type (fine, medium and coarse sands) and water depth. Particularly worthy of protection are areas in which different communities occur side by side. For these reasons, large areas of the identified sandbanks were placed under protection by the habitat area reports "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 ordinance of 22 September 2017 establishing the conservation area "Sylt Outer Reef – Eastern German Bight", the ordinance of 22 September 2017 establishing the conservation area "Dogger Bank", the ordinance of 22 September 2017 establishing the conservation area "Borkum Reef Ground" in the North Sea EEZ. There is currently no mapping instruction for the habitat type "Sandbanks which are slightly covered by sea water all the time".

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

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

The biotope type may be associated with the occurrence of rocks or mixed substrates and the occurrence of mussel beds, or may occur in spatial proximity to "sandbank" and "reef" biotopes. Reefs and species-rich gravel, coarse sand and shell layers occur regularly together. In the sublittoral of the North Sea, the biotope type is usually populated 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 richness of species and the high proportion of specialised species in these sediment types results from the occurrence of relatively stable spaces between the sediment particles with high pore water content and relatively high oxygen content. RACHOR & NEHMER (2003) have shown that the *Goniadella*-*Spisula* community occurs in two forms in the North Sea EEZ: the more species-rich one on coarse sand and gravel, and the species-poor one on coarse-medium sand. If there are rocks in the area, there is also typical epibenthic macrofauna. In the North Sea, except in the area around Helgoland, species-rich areas usually occur at depths of more than 20 m (ARMONIES 2010). Spatially, the colonisation of the biotope type is very heterogeneous.

The biotope type "Species-rich gravel, coarse sand and shell layers in marine and coastal regions" generally occurs in relatively small areas throughout the North Sea. It cannot be found in the Dogger Bank area and north of this in the German North Sea. Distribution is generally small-scale and patchy (see BFN 2011a).

There are relevant findings about the occurrence of species-rich gravel, coarse sand and shell layers in the area of the planned COBRAcable route for the Sylt Outer Reef and the Borkum Reef Ground.

2.5.2.4 Seapen and burrowing megafauna

communities

The biotope type "seapen and burrowing megafauna communities" is determined by the occurrence of seapens (Pennatularia), which are particularly sensitive to mechanical disturbances and damage. Besides seapens, the biotope type is characterised by an increased density of digger crabs (especially *Nephrops norvegicus, Calocaris macandreae, Upogebia deltaura, Upogebia stellata, Callianassa subterranea*). Each digger species forms characteristic systems of passageways in the seabed. These create the conditions for oxygen-rich water to penetrate deep into the soil and thus provide habitats for other species.

"Silty bottoms with burrowing megafauna" occur in the North Sea and the North-East Atlantic. The potential natural range results from the distribution of all characteristic species. In the German North Sea EEZ, this comprises in particular the Elbe-Urstromtal Valley and the adjacent areas with fine substrate sediments at depths of more than 15 m. "There are currently no known occurrences of seapens in the German North Sea" (BFN 2011b). There is no evidence for the biotope type "Silty bottoms with burrowing megafauna" without the occurrence of this characteristic species.

As comprehensive mapping of the above biotope types of the German North Sea is still lacking, no specific sites can be identified in the North Sea EEZ at present in which the biotopes "Species-rich gravel, coarse sand and shell layers in marine and coastal regions" and "Silty bottoms with burrowing megafauna" occur. In agreement with the Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU), the BfN has published a definition and mapping instructions for the survey of biotopes of species-rich gravel, coarse sand and shell layers and silty bottoms with burrowing megafauna (BFN 2011a & b).

2.5.3 Status estimation

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

2.5.3.1 Importance of areas and sites for biotopes

Area N-1

The legally protected biotopes "Sublittoral sandbanks" and "Species-rich gravel, coarse sand and shell layers" occur in area N-1. A northwestern extension of the "Borkum Reef Ground" sandbank, approximately 90,000 ha in area, projects into the eastern part of the "Borkum Reef Ground West 1" project site and occupies almost 50% of the area of the project site. The numerous suspect sites of "Species-rich gravel, coarse sand and shell layers" occurring in area N-1 are, in part, large areas that occupy larger parts of the project sites "Borkum Reef Ground West 1", "Borkum Reef Ground West 2" and "OWP West" (BIOCONSULT 2016b, 2017). In the opinion of the BfN, a larger area in the western part of the "Borkum Reef Ground West 2" project site is a biotope protected pursuant to section 30 of the Federal Nature Conservation Act. To date, not all known suspect sites in area N-1 have been investigated according to the mapping instructions of the BfN (BFN 2011a).

Area N-1 is considered to be of high importance overall due to the extensive occurrence of the biotopes "Sublittoral sandbanks" and "Species-rich gravel, coarse sand and shell layers" No sites are designated for area N-1 in the Site Development Plan.

Area N-2

A large part of area N-2 is located on the "Borkum Reef Ground" sandbank. The project sites "Borkum Reef Ground 1" and "Borkum Reef Ground 2" are located entirely on the sandbank, while the remaining project sites are partly on it. There are occurrences of the legally protected biotopes "Reefs" and "Species-rich gravel, coarse sand and shell layers" south to southwest of area N-2, especially in the area of the "Borkum Reef Ground" conservation area. Occurrences of this biotope are known within area N-2.

Area N-2 is overall of high importance for biotopes due to the large occurrence of the "Sublittoral sandbanks" biotope. The Site Development Plan does not identify regions in area N-2, but there may be areas planned for the construction of pilot wind turbines.

Area N-3

In area N-3, the near-surface sediments consist mainly of a fine to medium sandy top layer where the top few decimetres are rearranged regularly by hydrodynamic processes in the North Sea. The occurrence of legally protected biotopes is not known for much of the N-3 area. Only a small part in the southwest of the "Nordsee One" project site extends into the "Borkum Reef Ground" sandbank designated by the BfN. According to BfN's assessment, there are no indications of qualitative and functional characteristics of the biotope for this part of the sandbank.

No occurrence of protected biotopes is known in the designated areas N-3.5, N-3.6, N-3.7 and N-3.8. Due to the small overlap of area N-3 with the "Borkum Reef Ground" sandbank and the otherwise predominantly homogeneous, fine to medium sandy sediment conditions, area N-3 is considered to be of minor importance with regard to the protected asset Biotopes in the southwestern subarea.

Area N-4

There are no indications as yet of the occurrence of legally protected biotopes in area N-4 (IBL 2016). Area N-4 is therefore of minor importance with regard to the protected asset Biotopes. The Site Development Plan does not designate sites in area N-4.

Area N-5

Due to its location in the area of the Sylt Outer Reef, partly extensive occurrences of the legally protected biotopes and habitat types "Reefs" and "Sublittoral sandbanks" occur in area N-5. The legally protected biotope type "Species-rich gravel, coarse sand and shell layers" also occurs in area N-5. The BfN-designated sandbank in the western part of area N-5 is largely located within the "Sandbank" wind farm.

Area N-5 is of great importance with regard to biotopes due to the partly extensive occurrence of the biotopes "Sublittoral sandbanks", "Reefs" and "Species-rich gravel, coarse sand and shell layers".

Areas N-6, N-7, N-8, N-9, N-10, N-11, N-12, N-13

According to the available evidence, the occurrence of legally protected biotopes and habitat types in areas N-6 to N-13 can be excluded (PGU 2012a, b, PGU 2015, IfAÖ 2015a, b, IfAÖ 2016, BIOCONSULT 2018). Despite the occurrence of sediments with a high silt content and species of burrowing megafauna (chapter 2.6.3.1), the absence of seapens means that the legally protected biotope type "Seapen and burrowing megafauna communities" can be excluded. According to the current state of knowledge, the designated areas N-6.6, N-6.7, N-7.2, N-7.3, N-8.4, N-9.1 and N-9.2 are likewise not expected to contain legally protected biotopes and habitat types. Thus areas N-6 to N-13 and the sites designated therein are of minor importance for the protected asset Biotopes.

2.6 Benthos

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

With what are known as holobenthic species, all life phases take place within this ground-level community. However, the majority of animals are merobenthic, i.e. only certain phases of their life cycles are linked to this ecosystem (TARDENT 1993). These usually spread via planktonic larvae. In older stages, however, they are less capable of changing their location. Overall, most representatives of the benthos are characterised by a lack of or limited mobility compared to plankton and nekton. As a result, seabed fauna are generally hardly capable of avoiding natural and anthropogenic changes and pollution due to their relative local stability, and so in many cases these are an indicator of changed environmental conditions (RACHOR 1990a).

The North Sea bed largely comprises sandy or silty sediments, so animals can also penetrate the seabed. Besides the epifauna living on the surface of the seabed, typical infauna living in the seabed (syn. endofauna) have also developed. Small animals less than 1 mm in size (microfauna and meiofauna) make up the majority of these inhabitants of the seabed. Better known than these tiny creatures, however, are the larger animals, macrofauna, and above all the more stationary forms such as annelids, molluscs and snails, echinoderms and various crustaceans (RACHOR 1990a). Therefore, for practical reasons, the macrozoobenthos (animals > 1 mm) are examined internationally as representatives of the entire zoobenthos (ARMONIES & ASMUS, 2002). The zoobenthos of the North Sea comprise a multitude of systematic groups and demonstrate a wide variety of behaviours. All in all, this fauna has been studied fairly extensively and therefore permits comparisons with conditions a few decades ago.

2.6.1 Data availability

The description and assessment of the condition of macrozoobenthos in the North Sea is based not only on the available literature, but also on data collected within the scope of various environmental impact studies of offshore wind farm projects and accompanying ecological research. An essential basis is provided by evaluations of the R&D project "Bewertungsansätze für Raumordnung und Genehmigungsverfahren im Hinblick auf das benthische System und Habitatstrukturen" [Evaluation approaches for spatial planning and approval procedures with regard to the benthic system and habitat structures] (DANNHEIM et al. 2014a). A comprehensive database on benthic invertebrates and demersal fish was established within the scope of the project, enabling both temporal and spatial large-scale analyses of the occurrence of the animals in the German North Sea EEZ. For this purpose, benthic data from environmental impact studies from approval procedures for offshore wind farm and submarine cable procedures, as well as from research projects, were subjected to harmonisation and quality control and integrated to form a database. Moreover, the benthos was investigated by the Leibniz Institute for Baltic Sea Research Warnemünde, on behalf of the Federal Maritime and Hydrographic Agency and as part of biological monitoring, at 12 selected stations in the German EEZ between 2008 and 2011. Sampling took place twice a year (WASMUND et al. 2011).

A dataset for the entire North Sea was produced during the North Sea benthos surveys in April 1986. These surveys were initiated by the ICES Benthos Ecology Working Group (DUINEVELD et al. 1991). Various datasets for the German North Sea are available over several years, up to periods of two to three decades. The first benthic surveys in the German Bight were carried out by HAGMEIER (1925) in the 1920s. These studies provide basic information on the structure of macrozoobenthos communities. These surveys were continued by ZIEGELMEIER (1963, 1978) between 1949 and 1974. RACHOR (1977, 1980) investigated the macrofauna communities of the inner German Bight from 1969 onwards and found a decrease in species numbers. RACHOR & GERLACH (1978) analysed sandy areas of the German Bight with regard to the effects of severe storms on benthic communities.

KRÖNCKE (1985) and VON WESTERNHAGEN et al. (1986) investigated the influence of extremely low oxygen concentrations on macrozoobenthos in the German Bight and Danish waters from the summer of 1981 to 1983. These surveys showed a decrease in the species number and biomass, as well as an increase in opportunistic species.

Fast regeneration of these macrozoobenthos communities was determined over the next few years, 1984 to 1989, without oxygen deficiency situations (NIERMANN 1990 and NIERMANN et al. 1990).

The analysis of long-term datasets showed changes in the composition of the macrobenthos. No significant change in benthic communities compared to Hagmeier's studies could be determined at this point in the comparison of the 1923 and 1965 – 1966 datasets from the German Bight as compiled by STRIPP (1969 a/b). NIERMANN (1990) compares Hagmeier's and Stripp's data with his studies from 1984 to 1989 and describes a doubling of biomass caused by factors such as the increase in *Echinocardium cordatum* and opportunistic species such as *Phoronida*. SALZWEDEL et al. (1985) in turn surveyed the entire German Bight and found an increase in biomass compared to earlier surveys. Nutrient richness is indicated as a possible reason.

RACHOR (1990b) describes changes in macrozoobenthos communities on different sediment types due to eutrophication. According to these surveys, sandy sediments are influenced more strongly than silt by the input of organic material. During surveys of the epibenthos of the German Bight, REISE & BARTSCH (1990) discovered that the fauna were more diverse in the past than in their own surveys. Further research shows that fishing with heavy ground tackle leads to changes in benthic communities, leading to observance of a decline in long-lived and fragile species within the communities studied (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 small changes 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 communities in the defined territories. Based on data from 41 wind farm projects and 15 AWI projects between 1997 and 2014, this study performed analyses of benthic communities on a large scale for the entire EEZ, and on a regional scale for the areas.

The description of the sites designated in the Site Development Plan is essentially based on the information collected in the original environmental impact studies for these sites and summarised in the corresponding permits. The surveys on which the environmental impact studies are based date from 2002 to 2010, depending on the site.

For site N-3.7, a relevant assessment of local conditions was presented in a short study (BIOCONSULT 2016a). The results of operational monitoring from adjacent wind farm projects in this site were also used with regard to designated regions in area N-6 (PGU 2017). Findings are available from the supplementary baseline survey (BIOCONSULT 2018) and the operational monitoring (IFAÖ 2016) of adjacent wind farm projects for the sites designated in area N-8.

2.6.2 Spatial distribution and temporal variability

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

Wind-induced currents are responsible for the distribution of planktonic larvae and redistribution of demersal stages due to current-induced sediment rearrangements (ARMONIES 1999, 2000a, 2000b). Among the anthropogenic impacts, besides nutrient and pollutant discharges, disturbance of the surface of the seabed by fishing is of particular importance (RACHOR et al., 1995). Fishing with bottom trawls can affect the structure and trophic function of benthic communities (DANNHEIM et al. 2014b), even sites previously damaged heavily (REISS et al. 2009).

The following natural spatial classification of the German North Sea EEZ in respect of benthological aspects differs from the natural spatial classification according to sedimentological criteria. The macrozoobenthos shows a strong bond to the sediment structure (KNUST et al. 2003). However, sediment conditions are not the sole factor. Water temperature and the hydrodynamic system (currents, wind, water depth) are also among the main structuring natural factors in the German Bight that are responsible for the composition of the macrozoobenthos. The work by RACHOR & NEHMER (2003) therefore subdivides the data into seven natural spatial units (abbreviations A – G), which are listed in Table 7 and shown graphically in Figure 16, taking hydrography and topography into account.

The Elbe-Urstromtal Valley and – in the outer area – Dogger Bank are key guide structures in the German North Sea EEZ. These are important for the linking of habitats, as stepping stones and as retreat areas, for example. Dogger Bank also provides a biogeographical divide between the northern and southern North Sea.

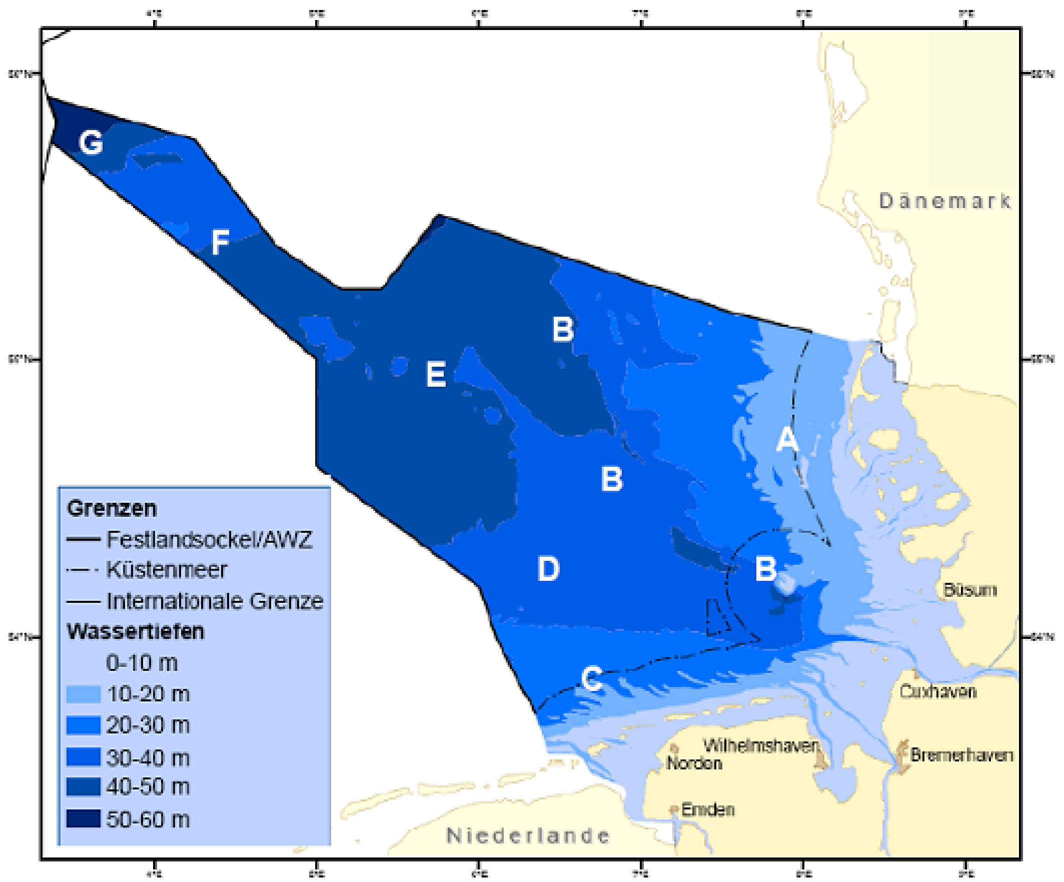


Figure 16: Nature spatial classification of the German North Sea EEZ according to RACHOR & NEHMER (2003), final report for BfN.

Table 7: Natural spatial units of the German North Sea EEZ and in Site Development Plan territories (according to RACHOR & NEHMER 2003).

ABBREVIATION, see Figure 16	DESIGNATION	HYDROGRAPHY	TOPOGRAPHY	SEDIMENT*	BENTHOS
A	Eastern German Bight (North Frisian EEZ) with Sylt Outer Reef	alternating 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; residual current moving northwards (CCC)	from -10 to -43 m	Heterogeneous sediment distribution from fine to coarse sands, isolated gravel and rock areas	predominantly **Tellina fabula** community (dominant species: ribbed tellin and Spionidae [annelids]), adaptable; in the direction of the coast: sub-littoral variations of the Macoma balthica community; **Goniadella-Spisula comm.** high species diversity in biotope mosaics with often lower population densities
B	Elbe-Urstromtal Valley	Seasonal body of water, at times stratified, regionally with oxygen depletion; lower-salinity coastal waters can lie above higher-salinity water	elongated, on the eastern slope steeper hollow pattern to -50 m	Fine sands with silt portions that increase with the depth of the water	**Amphiura filiformis community** (dominant species: brittle star); in subregions burrowing megafauna possible; Nucula nitidosa community in the coastal silt and silt-sand areas
C	Southwest German Bight (coastal East Frisian EEZ with Borkum Reef Ground)	Inflow of Atlantic water from the canal and the western North Sea; eastern current	from -20 to -36 m	heterogeneous sediment distribution from fine to coarse sands, sporadic gravel and individual rock deposits	predominantly **Tellina fabula** community (dominant species: ribbed tellin and Spionidae), adaptable; and **Goniadella-Spisula comm.** high species diversity in biotope mosaics with often lower population densities
D	Northwest German Bight (offshore East Frisian EEZ)	Under North Sea water influence; slight eastern current	from -30 to -40 m	Silty fine sand	**Amphiura filiformis community** (dominant species: brittle star); in subregions burrowing megafauna possible
E	Transition region between German Bight and Dogger Bank	Slight tidal dynamic with slighter amplitude; stratified body of water in the summer; higher salinity with slighter variability; oxygen deficiency possible	Depths from -38 (shallow bottom of the White Bank) to -50 m	Silty fine sand	**Amphiura filiformis community** (dominant species: brittle star); in subregions burrowing megafauna possible

ABBREVIATION, see Figure 16	DESIGNATION	HYDROGRAPHY	TOPOGRAPHY	SEDIMENT*	BENTHOS
F	Dogger Bank	eddy and frontal formation on the slope positions; strong vertical mixing on the bank, body of water rarely stratified	Depths from -29 to -40m, becoming shallower towards the west	Fine to medium sand	Offshore fine sand community **Bathyporeia Tellina community**
G	Central North Sea north of Dogger Bank	Water regularly is stratified in the summer months	Depths over -40 m	Fine sand, in places till or clay	Benthos community of the central North Sea, Myriochele

*modified Federal Maritime and Hydrographic Agency

2.6.2.1 Current species spectrum of the North Sea EEZ

There are currently about 1,500 known marine macrozoobenthos species in the North Sea. An estimated 800 of these are found in the German North Sea area, 700 in the sublittoral of the open southeastern North Sea (RACHOR et al. 1995). Surveys on the benthos of the EEZ were carried out in May/June 2000 as part of the R&D project "Erfassung und Bewertung ökologisch wertvoller Lebensräume in der Nordsee" [Recording and assessment of ecologically valuable habitats in the North Sea] (RACHOR & NEHMER 2003) using van Veen sediment samples at 181 stations and with an additional 79 beam trawl hauls. A total of 483 taxa (of which 361 to the species) of endofauna and epifauna were identified, including demersal fish. The groups Polychaeta (polychaetes) with 129 species, Crustacea (crustaceans) with 101 species and Mollusca (molluscs) with 66 species made up the largest share. A total of 336 invertebrate macrozoobenthos species were identified.

The species composition recorded by RACHOR & NEHMER (2003) can be supplemented by the surveys carried out within the framework of various offshore wind farm and submarine cable projects, as well as additional AWI research projects. Based on taxonomic harmonisation of this extensive benthos database, 573 species of benthic infauna alone were found in the German EEZ between 1997 and 2014 (DANNHEIM et al. 2016). In total, this results in a total of approximately 750 species of invertebrate macrozoans in the German EEZ. In the ranking of species diversity of individual large groups, the polychaetes group is the most species-rich, followed by the crustaceans and the molluscs.

Within the framework of the biological monitoring carried out by the Leibniz Institute for Baltic Sea Research Warnemünde, a total of 286 species (spring and autumn sampling at all stations, combined) were determined in 2010. Along the stations, species diversity ranged from 37 in the North Frisian Islands to 121 at Entenschnabel. If spring and autumn sampling are considered separately, the number of species in spring varied from 16 in the North Frisian Islands to 90 at Entenschnabel. Species diversity was always higher in autumn (WASMUND et al. 2011).

2.6.2.2 Red List species

In May 2014, the current Red List of demersal invertebrates was published by RACHOR et al. (2013) via the BfN. By including additional animal groups compared to the 1998 Red List, assessments have been made for a total of 1,244 macrozoobenthos taxa within the current Red List. According to the study, 11.7% of all assessed taxa are endangered, a further 16.5% are potentially endangered as probably largely stable but extremely rare species. If the 3.9% disappeared species are added (48 of the total of 49 disappeared species being found only in the Helgoland area), a total of 32.2% of all species evaluated are assigned to a Red List category.

In a recent study by DANNHEIM et al. (2016), a total of 98 species of benthic invertebrates which are listed as endangered or extremely rare according to RACHOR et al. (2013) were detected in the German EEZ between 1997 and 2014.

Two of the species identified are considered extinct (*Modiolula phaseolina* und *Ascidia virginea*). Detection of the sea squirt *Ascidia virginea* is a misidentification according to the latest findings. According to the redefinition, this is very probably the extremely rare (Red List cat. R) species *Ascidiella scabra* (J. DANNHEIM pers. communication, species list currently under revision).

The two species *Nucula nucleus* and *Spatangus purpureus* are classified as being threatened with extinction (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). For a total of 33 species an indeterminate threat (Red List cat. G) is to be assumed, 45 species are extremely rare (Red List cat. R). In addition to this total of 98 Red List species, there are a further 17 species on the Early Warning List. The large taxonomic groups with the highest number of species on the Red List are molluscs (Bivalvia, 30 species), polychaetes (Polychaeta, 26 species) and amphipods (20 species).

According to a recent study by DANNHEIM et al. (2016), the benthic Red List species are not distributed homogeneously throughout the German EEZ. Overall, more Red List species occur further away from the coast, with up to 15 Red List species per station in the Dogger Bank area. Local hotspots in terms of species number and abundance of Red List species can be found mainly in the area of Dogger Bank, the Sylt Outer Reef and northwest of the Sylt Outer Reef (Figure 17). According to DANNHEIM et al. (2016), the distribution of Red List species in the German EEZ is determined not only by their distance from the coast, but also by the water depth, temperature and sediment properties, and thus does not differ significantly from the distribution patterns of the rest of the benthic fauna.

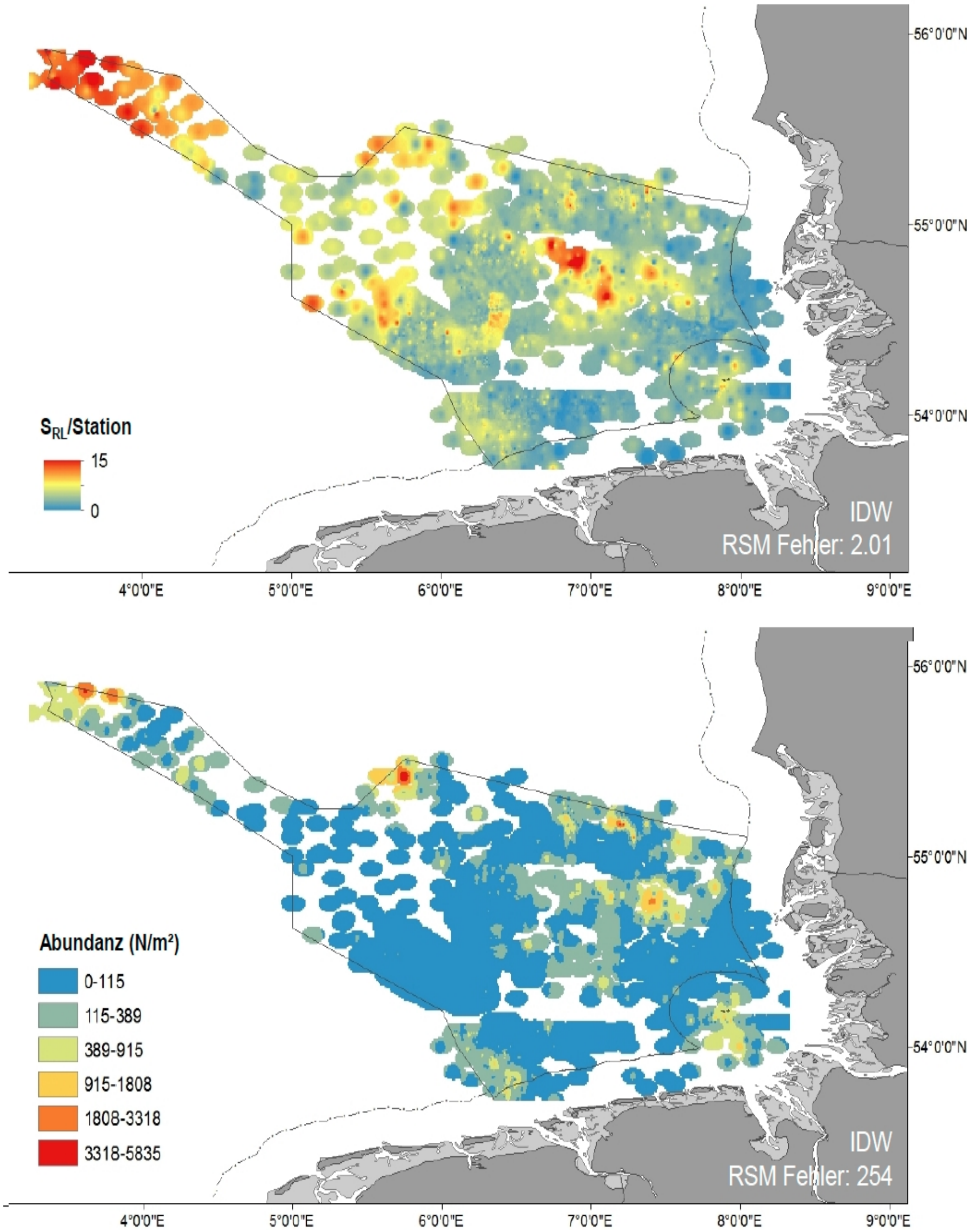


Figure 17: Species number (top) and abundance (bottom) of benthic Red List species in the German EEZ territory (from DANNHEIM et al. 2016).

2.6.2.3 Symbiotic communities

In general, infauna is distributed in correlation to water depth and sediment. The distribution pattern of the benthic animal communities described by SALZWEDEL et al. (1985) and, in principle, by HAGMEIER (1925) was confirmed again and again, although there are survey-dependent and time-dependent differences in dominance conditions and the occurrence of individual species, as well as in minor details. The overall distribution of benthic endofauna communities in the North Sea based on a mapping operation coordinated by the ICES Benthos Ecology Working Group and carried out in 1986 is documented in KÜNITZER et al. (1992).

Clear south-north zoning was determined here (HEIP et al. 1992), which is mainly due to the water depths and the associated temperature and stratification conditions. The distribution of the communities within this large-scale zoning is determined mainly by the sediments.

The settlement areas of the macrozoobenthos (RACHOR & NEHMER 2003) recorded with grab samplers in the southeastern North Sea in 2000 are shown

Figure 18 in simplified form. 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 are changing, mainly due to fishing with heavy ground tackle gear; some formerly abundant species such as *Arctica islandica* are now rare.

The variants of the *Goniadella-Spisula* community, often associated with rock reefs and rock fields, occur in the area of the Borkum Reef Ground and, in particular, east of the Elbe-Urstromtal Valley. In the case of larger rock accumulations, there is some protection against seabed fishing: however, these biotope mosaics are now threatened by gravel and sand degradation.

The *Myriochele* community found in the transitional area to the central North Sea north of Dogger Bank is widespread outside the German EEZ. For German waters, however, this community is unique. This is another reason why there are so many species on the Red List for the German marine area, according to RACHOR et al. (2013) (see Figure 17).

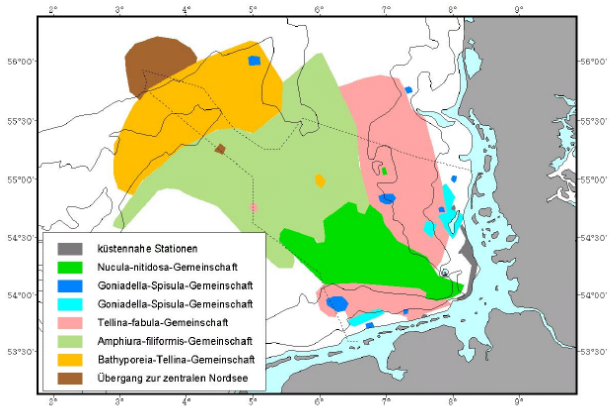


Figure 18: Settlement areas of the most important benthic animal communities (macrozoobenthos, according to sediment samples) in the German North Sea EEZ and adjacent areas (from RACHOR & NEHMER 2003, final report for BfN); the picture is incomplete in the area of the coastal waters.

Based on data from 41 wind farm projects and 15 AWI projects between 1997 and 2014, DANNHEIM et al. (2014a) performed analyses of benthic communities on a large scale for the entire EEZ, and on a regional scale for the areas.

For benthic **epifauna**, six significantly different communities could be identified on major and regional scales (Figure 19). However, the identified associations are not clearly distinguishable units on a spatial level, but reflect gradual changes in the abundance conditions between coastal and offshore stations in a substantially constant structural species composition. Dominant and regularly occurring characteristic species throughout the EEZ are *Asterias rubens* (common starfish), *Astropecten irregularis* (sand sea star), *Crangon* spp. (common shrimp), *Liocarcinus holsatus* (flying crab), *Ophiura ophiura* (serpent star), *Ophiura albida* (serpent's table brittle star) and *Pagurus bernhardus* (common hermit crab). The coastal communities in particular are characterised by some dominant species (e.g. *Crangon spp.* and *Ophiura albida*), while the dominance conditions in offshore coastal regions are more balanced. The more productive coastal regions also have higher abundances and biomass values than the offshore regions.

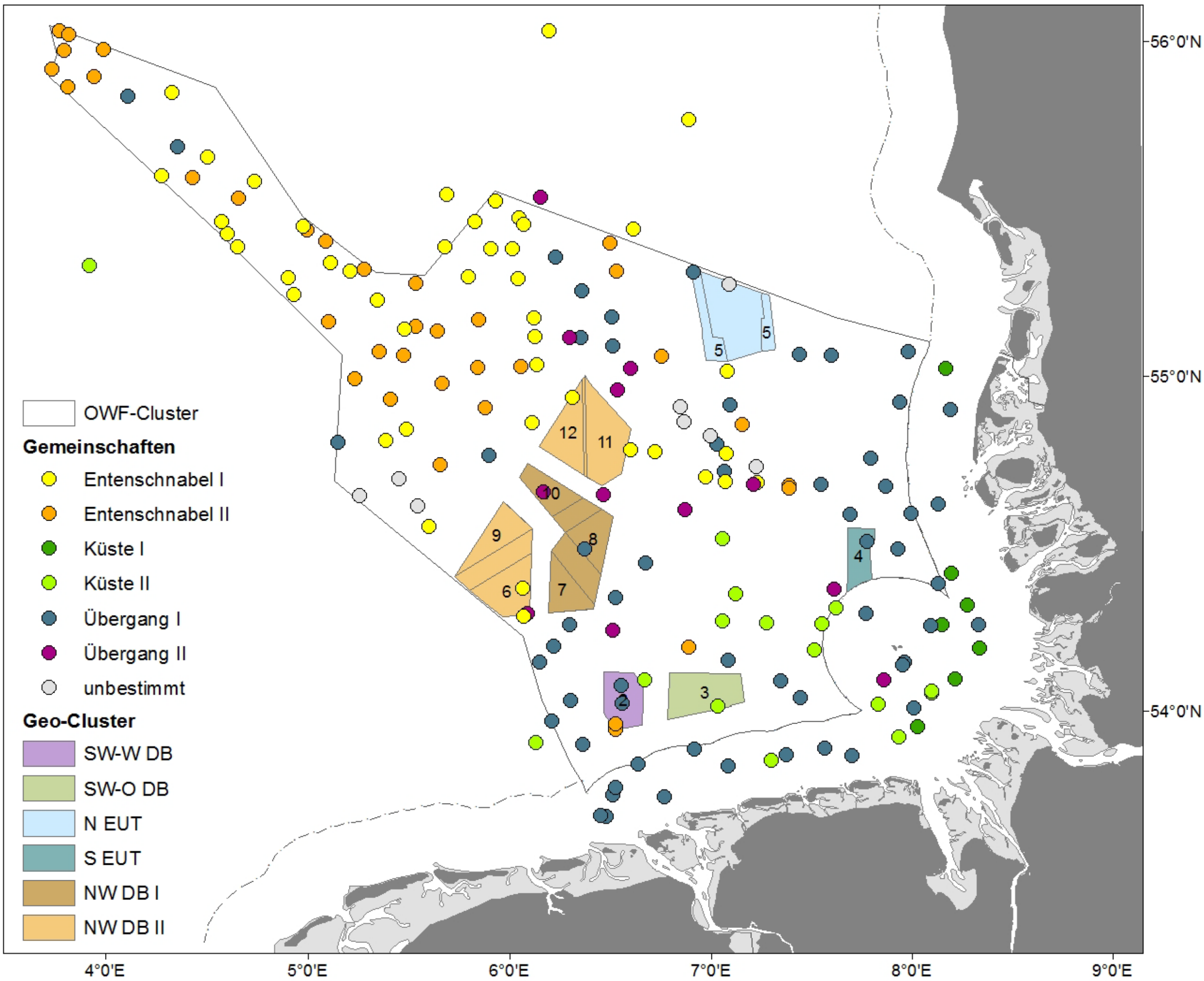


Figure 19: Identified large-scale communities and regional geo-clusters based on abundances of epifauna in the German North Sea EEZ (according to DANNHEIM et al. 2014a). SW-W DB = Western Southwest German Bight, SW-O DB = Eastern Southwest German Bight, N EUT = Northern Elbe-Urstromtal Valley, S EUT = Southern Elbe-Urstromtal Valley, NW DB I = Northwest German Bight I, NW DB II = Northwest German Bight II.

For benthic **infauna**, the communities of the German EEZ described by SALZWEDEL et al. (1985) and RACHOR & NEHMER (2003) could be confirmed with the associated characteristic species (Figure 20). Besides the established communities, seven other communities were identified which essentially represent gradual transitional communities between the established associations. In contrast to the epifauna, no clear gradients are recognisable for the infauna as a function of the distance to the coast. Rather, according to DANNHEIM et al. (2014a) the sediment properties have the greatest influence on the composition of the infauna. This in turn leads to a relatively high degree of small-scale variability in the faunistic structure of the infauna, especially in sedimentologically heterogeneous areas such as the Amrumbank and the Sylt Outer Reef.

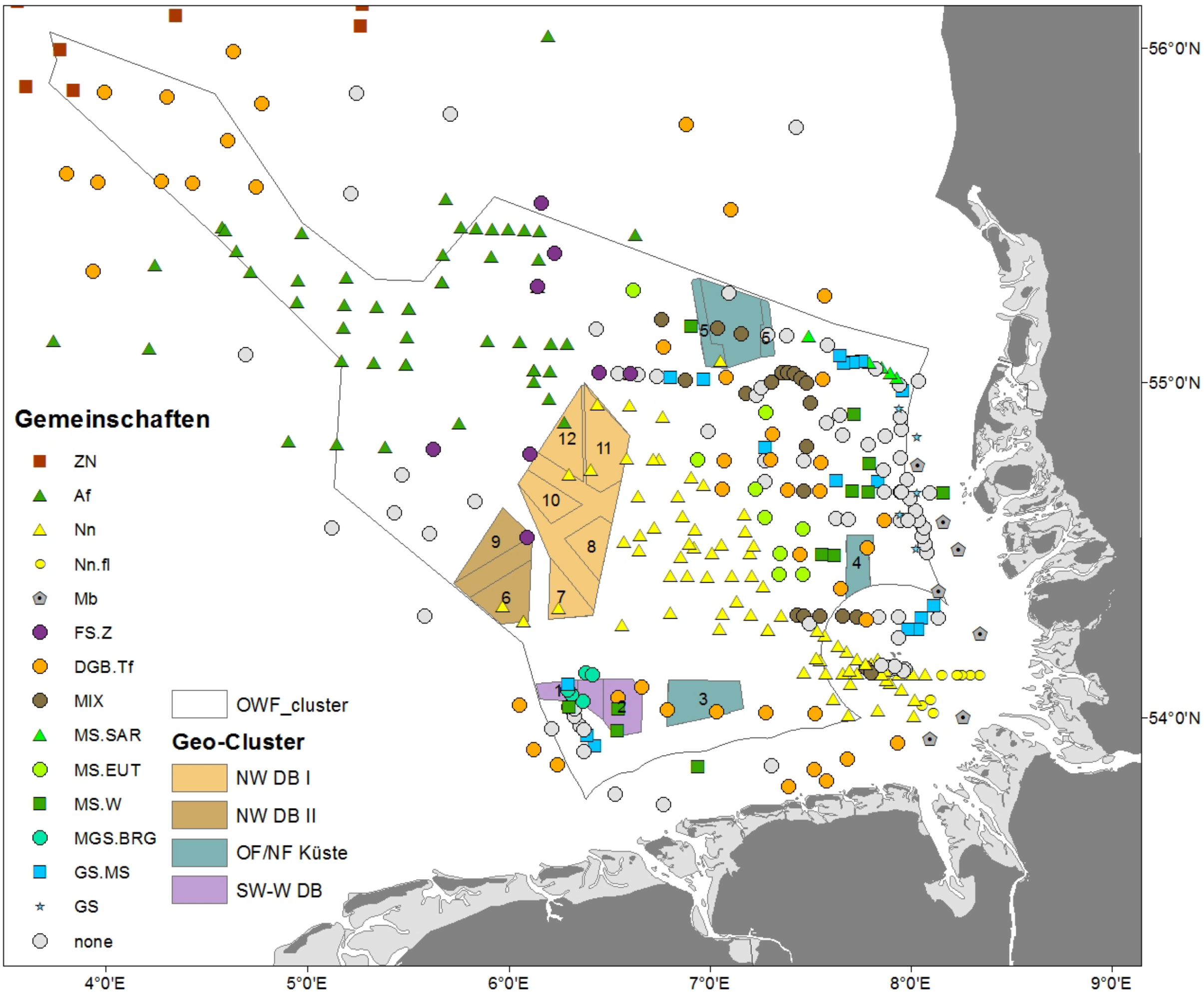


Figure 20: Identified large-scale communities and regional geo-clusters based on abundances of infauna in the German North Sea EEZ (according to DANNHEIM et al. 2014a). Clusters: ZN = Central North Sea, Af = Amphiura filiformis community, Nn = Nucula nitidosa community, Nn.fl = shallow Nucula nitidosa community, Mb = Macoma balthica community, FS.Z = fine sand, central, DBG.Tf = Dogger Bank/Tellina fabula community, MIX = heterogeneous sands, MS.SAR = medium sand, Sylt Outer Reef, MS.EUT = medium sand, ElbeUrstromtal Valley, MS.W = medium sand, West, MGS.BRG = medium/coarse sand, Borkum Reef Ground, GS.MS = Coarse sand/medium sand, GS = Goniadella/Spisula medium/coarse sand, none = not defined. Geo-clusters: SW-W DB = west southwest German Bight, OF/NF Coast = East Frisian/North Frisian coast, NW DB I, II = North West German Bight I, II.

2.6.3 Status assessment of the factor Benthos

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

Criterion: Rareness and vulnerability

The number of rare or endangered species is taken into account here. The rarity/vulnerability of the population can be estimated based on the identified Red List species.

According to the currently available studies, the macrozoobenthos of the North Sea EEZ is also considered average due to the identified number of Red List species. This assessment is supported by the fact that in the Red List by RACHOR et al. (2013), a total of 400 species of 1,244 assessed species could be assigned to a Red List category. The 400 species represent more than 30% of the total population.

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

Two species considered extinct (Red List cat. 0) and two species threatened with extinction (Red List cat. 1) have been identified. In the meantime, identification of one extinct species has proven to be a misidentification (J. DANNHEIM pers. communication). That said, RACHOR et al. (2013) list 49 Red List cat. 0 species and eight Red List cat. 1 species. The individual consideration of the natural spatial units defined by RACHOR & NEHMER (2003) does not lead to any different assessment of the condition 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 biocoenoses characteristic of the habitat occur and how regularly they occur is assessed.

The species inventory of the North Sea EEZ can be regarded as average with currently around 750 identified macrozoobenthos species (excluding fish), as a total of about 1,500 marine macrozoobenthos species are currently known in the North Sea and, according to RACHOR et al. (1995), an estimated 800 were found in the German North Sea region. The benthic communities also have no special features, since the main structuring natural factors for the composition of macrozoobenthos in the German Bight are the water temperature, the hydrodynamic system (currents, wind, water depth) and the resulting sediment composition (KNUST et al. 2003).

According to the predominant sediments, the largest areas are occupied by the *Amphiura filiformis*, *Tellina fabula* and *Nucula nitidosa* communities. The *Goniadella-Spisula* community predominates in coarse sandy areas. However, their occurrence extends beyond the German EEZ. The *Myriochele* community joins Dogger Bank to the north and is widespread outside the German EEZ (RACHOR et al. 1998). Overall, all the benthic communities found in the region are not of outstanding importance. According to KRÖNCKE (2004), the six benthic communities occurring in the North Sea are characterised by frequently represented standard forms. However, this did not mean that their respective species inventories were limited to individual communities. Only the abundances are characteristic, but the individual species are also present in the other communities. Therefore, it is not possible to distinguish these communities in terms of their importance; rather, all communities have the same value.

Criterion: Naturalness

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

As regards the naturalness criterion, it should be noted that the benthos deviates from its original state due to previous contamination (fishing, eutrophication and pollutant inputs). Particularly noteworthy here are the disturbances of the surface of the seabed due to intensive fishing activities, which cause a shift from long-lived species (molluscs) to short-lived, rapidly reproducing species. Therefore, neither the species composition nor the biomass of zoobenthos today corresponds to the state that would be anticipated without human utilisation (ARMONIES & ASMUS 2002).

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

2.6.3.1 Importance of areas and sites for benthic communities

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

Areas N-1 and N-2

The regional geo-cluster SW-W DB (western southwest German Bight) identified by DANNHEIM et al. (2014a) based on a comprehensive analysis of data from wind farm and AWI projects comprises areas N-1 and N-2 (Figure 20). Comparing the two areas, area N-1 has greater overall structural heterogeneity of benthic communities and the second highest heterogeneity of all areas. The dominant characteristic species in areas N-1 and N-2 were the polychaetes *Magelona* spp., *Spiophanes bombyx, Nephtys cirrosa and amphipods of the genus Bathyporeia spp.* Areas N-1 and N-2 have local hotspots (Figure 17) with regard to the number of species and abundance of Red List species. The variants of the *Goniadella-Spisula* community occurring in these areas are of great importance in terms of rarity and vulnerability due to the relatively high number of Red List species. In its more species-poor form, this community is of medium importance in terms of diversity and uniqueness. However, it is of great importance in this respect in areas that are to be classified as "Species-rich gravel, coarse sand and shell layers" according to section 30 of the Federal Nature Conservation Act. The *Goniadella-Spisula* community has a medium to high naturalness due to relatively low overall fishing intensity (< 1 event per year) in the Borkum Reef Ground area. Overall, the *Goniadella-Spisula* communities occurring in areas N-1 and N-2 are rated as medium in their more species-poor form, but high in their species-rich form.

Areas N-3, N-4 and N-5

The coastal geo-cluster "OF/NF Coast" (East Frisian/North Frisian coast) in areas N-3, N-4 and N-5, defined by the analysis by DANNHEIM et al. (2014a), is similar in species composition to the community in areas N-1 and N-2. Here, too, the polychaetes *Magelona* spp. and *Spiophanes bombyx* were the predominant characteristic species besides Nemertea and Phoronida. The community found in these areas showed the highest abundances overall. The highest structural heterogeneity of benthic communities compared to all areas was found in area N-5, mainly due to the high variability in the "Dan Tysk" and "Sandbank" wind farms.

Designated sites in area N-3

In area of sites N-3.5, N-3.6 and N-3.8, relatively homogeneous, fine to medium sandy sediments are present in the near-surface top layer of the seabed. The community occurring in these areas is predominantly the *Tellina fabula* association. There is a transition area to the *Nucula nitidosa* community in the northern part of area N-3. The high occurrence of the polychaetes *Magelona johnstoni* and *Spiophanes bombyx* in this area confirms the occurrence of the geo-cluster "OF/NF Coast" described in DANNHEIM et al. (2014a).

A stable transitional form between the *Tellina fabula* community and the *Nucula nitidosa* community could also be demonstrated for site N-3.7 (BIOCONSULT 2016a). Small-scale differences in the community structure could not be demonstrated, and hard substrate communities were not present. The benthic communities found in the designated sites of area N-3 are neither rare nor endangered in the North Sea EEZ. Overall, the benthic communities can be ascribed low to medium importance due to average species diversity and the number of Red List species, as well as the previous contamination due to fishing.

Areas N-6 and N-9

DANNHEIM et al. (2014a) identified the geo-cluster NW DB II (Northwest German Bight II) in areas N-6 and N-9. The community occurring in these areas essentially corresponds to the *Amphiura filiformis* association with elements of the *Nucula nitidosa* association, which occur mainly in area N-6. The dominant characteristic species in areas N-6 and N-9 were the mud shrimp *Callianassa subterranea*, the polychaete *Nephtys hombergii*, the brittle star *Amphiura filiformis* and the phoronids. Overall, these areas had the lowest average abundance and number of species compared to the other geo-clusters.

Designated sites in area N-6

Results from the monitoring of the adjacent offshore wind farms BARD Offshore 1, Veja Mate and Deutsche Bucht within area N-6 (PGU 2017) can be used with regard to the characterisation of benthic communities in the region of the designated sites N-6.6 and N-6.7. Biodiversity in the adjacent wind farms varied between 120 and 147 species. The most common species were the brittle star *Amphiura filiformis*, followed by the molluscs *Corbula gibba*, *Nucula nitidosa* and *Thracia phaseolina*. That said, the sea potato *Echinocardium cordatum*, followed by the common tower shell *Turitella communis* and the polychaete *Nephtys hombergii*, had the largest share of the total biomass.

The number of Red List infauna species according to RACHOR et al. (2013) varied between 15 and 21 species in area N-6. Only a few individuals of the mollusc *Spisula elliptica* considered critically endangered (Red List category 2) and the molluscs *Arctica islandica* and *Goodallia triangularis* classified as endangered, as well as the sigalionid worm *Sigalion mathildae*, were detected. Two species of burrowing megafauna have also been identified. The species *Callianassa subterranea*, classified as being of least concern, was found relatively frequently, while the species *Upogebia deltaura*, classified as being subject to an indeterminate threat, was found only in small numbers.

Despite the average diversity of species and the number or abundance of Red List species, the benthic community in the designated sites of area N-6 is considered to be of average to above-average importance due to the occurrence and ecological importance of burrowing megafauna.

Designated sites in area N-9

The benthic community in area N-9 and thus the designated sites N-9.1 and N-9.2 of the

Amphiura filiformis association can be assigned based on the data collected in 2008–2009. Between 128 and 130 macrozoobenthos taxa were found within the sites of area N-9 (PGU 2012a, b; PGU 2015). Despite relatively great temporal variability in species composition, the same species as in area N-6 – *Nucula nitidosa, Corbula gibba, Nephtys hombergii* and *Amphiura filiformis* – dominated the benthic community. In addition, the dominant species were the horseshoe worm *Phoronis* spp., the mud shrimp *Callianassa subterranea* and polychaetes of the genus Nephtys. The sea potato *Echinocardium cordatum* and the common tower shell *Turitella communis* also dominated in area N-9 in terms of biomass.

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

The benthic community in the location of the designated sites in area N-9 is assigned average to above-average importance due to the occurrence of burrowing megafauna species.

Areas N-7, N-8, N-10, N-11, N-12 and N-13

DANNHEIM et al. (2014a) identified the geo-cluster NW DB I (Northwest German Bight I) in areas N-7, N-8 and N-10 to N-12. These offshore areas are mainly characterised by the mollusc *Nucula nitidosa* and the polychaete *Nepthys hombergii*.

The benthic community in area N-13 is primarily the *Amphiura filiformis* community, with some elements of the *Nucula nitidosa* association (IFAÖ 2015c, d). Characteristic species of these communities in the studies were mainly the brittle star *Amphiura filfiformis*, the molluscs *Mysella bidentata*, *Nucula nitidosa*, *Abra alba* and the polychaete *Scalibregma inflatum*.

The species diversity and Red List species number can be described as average for the stated areas as a whole. The benthos is of average to above-average importance overall in these areas due to the ecological importance of the burrowing megafauna species found during the surveys of the areas in question.

<u>Designated sites in area N-7</u>

The results of the benthic surveys for area N-7 from 2002 to 2010 can be used with regard to the description of the benthic communities in the region of the designated sites N-7.2 and N-7.3. Essentially, area N-7 is a transitional community of the *Nucula nitidosa* community with the *Tellina fabula* association adjacent to the south and the *Amphiura filiformis* community to the north. These communities are widespread in the North Sea EEZ and are not endangered.

The species diversity of the infauna in the southern part of area N-7 comprised 122 taxa, Polychaeta being the most species-rich, followed by Crustacea and Mollusca. The most dominant species was *Nucula nitidosa*. Other dominant species were the polychaete *Nepthys hombergii* and the mollusc *Corbula gibba*. The biomass was determined by the sea potato *Echinocardium cordatum* and the common tower shell *Turitella communis*. Of the two species of burrowing megafauna, *Callianassa subterranea* was found relatively frequently, whereas *Upogebia deltaura* was found only in small numbers.

The benthic community in the location of the designated sites in area N-7 is assigned average to above-average importance due to the occurrence of burrowing megafauna species. The species diversity and number of Red List species in this area is to be regarded as average.

<u>Designated site in area N-8</u>

Current results of the operational monitoring and supplementary baseline survey of adjacent wind farms can be used to describe and evaluate the designated site N-8.4 (IFAÖ 2016, BIOCONSULT 2018).

The benthos in the region of area N-8, and thus in site N-8.4 as well, can be assigned to the *Amphiura filiformis* community, but also has elements of the *Nucula nitidosa* association. Between 146 and 169 taxa of benthic infauna and 22 to 38 taxa of benthic epifauna were identified in the region of site N-8. Dominant species with regard to abundance were the brittle star *Amphiura filiformis*, the molluscs *Nucula nitidosa* and *Corbula gibba* and the horseshoe worm *Phoronis* spp. The biomass was mainly determined by the sea potato *Echinocardium cordatum* and the common tower shell *Turitella communis*.

To date, 23 to 31 infauna species and between 16 and 23 epifauna species in area N-8 have been identified as endangered or rare in accordance with the Red List according to RACHOR et al. (2013). The molluscs *Ensis ensis* and *Mya truncata*, the common whelk *Buccinum undatum*, the polychaete *Sabellaria spinulosa* and the mud shrimp *Upogebia stellata* have been identified as critically endangered (Red List category 2). The ocean quahog *Arctica islandica*, the polychaete *Sigalion mathildae* and the sea anemone *Sagartiogeton andatus*, all of which are considered endangered (Red List category 3), were also found in low abundance in area N-8. Four species of burrowing megafauna were found (*Callianassa subterranea*, *Upogebia deltaura*, *U. stellata* and *Nephrops norvegicus*), although only the species *Callianassa subterranea*, which is regarded as being of least concern, was 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 burrowing megafauna, the importance of benthos in area N-8 and site N-8.4 can be deemed to be average to above-average.

2.7 Fish

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

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

Weakening of the synchronicity between temperature-controlled zooplankton development and day length-controlled phytoplankton development is another mechanism by which increased temperatures due to climatic changes can influence the population dynamics of fish. This "mismatch" (CUSHING 1990, BEAUGRAND et al. 2003) may reduce the density of zooplankton found by fish larvae if they are dependent on external nutrition after consuming their yolk sacs. The significance of this phenomenon results from the fact that the survival rates of early life stages across species have a disproportionate effect on population dynamics (HOUDE 1987, 2008). This variability can propagate to the predators at the top of the food chain (DURANT et al. 2007, DÄNHARDT & BECKER 2011), which also includes fishing.

Climate change could indirectly impact marine fish communities, as humans react to climate change by installing offshore wind farms (EEA 2015). On the one hand, this would create large areas from which fishing would be excluded. On the other, however, artificial hard substrates would be introduced on a large scale, thus creating habitats for species that do not otherwise occur in the areas in question (EHRICH et al. 2007). That said, climate change and fishing are not the only factors affecting fish populations. For instance, TEMMING & HUFNAGL (2014) use the large seal population, among other factors, to explain the permanently low populations of whiting *Merlangius merlangus* and Atlantic cod *Gadus morhua* in the southern North Sea.

The lives of adult animals are used for initial subdivision of fish fauna. Demersal species (species that live on the seabed) can be distinguished from pelagic species (those living in open waters). Mixed forms – benthopelagic species – are also widespread. However, this separation is not strict: demersal fish regularly ascend into the water column, while pelagic fish occasionally stay near the seabed. At almost 60%, demersal fish account for the largest share ahead of pelagic (20%) and benthopelagic (15%) species. Only approximately 5% cannot be assigned to any of the three types due to close habitat affinity (www.fishbase.org). The individual life stages of species often differ more widely from one another in terms of form and behaviour than the same stages of different species: the pelagic Atlantic herring *Clupea harengus* lays its eggs in thick mats on sandy-gravelly seabed or sticks them to suitable substrates such as algae or rocks (DICKEY-COLLAS et al. 2015), all flatfishes have pelagic larvae, which metamorphose into the characteristic body shape for life on the seabed (VELASCO et al. 2015), and benthopelagic fish such as Atlantic cod produce pelagic eggs and larvae (HISLOP et al. 2015). The vast majority of fish species found in the North Sea, from eggs to adult spawning fish, complete their entire life cycles there and are therefore referred to as *permanent residents* (LOZAN 1990). These include 11 commercial species (Atlantic herring, Norway pout *Trisopterus esmarkii*, sand eel *Ammodytes spec*., Atlantic mackerel *Scomber scombrus*, European sprat *Sprattus sprattus*, Atlantic cod, haddock *Melanogrammus aeglefinus*, saithe *Pollachius virens*, European plaice *Pleuronectes platessa*, common sole *Solea solea* and whiting), which collectively account for 90% of catches. There are also economically insignificant species (viviparous eelpout *Zoarces viviparus*, dealfish *Trachipterus arcticus*, sea stickleback *Spinachia spinachia*, Vahl's eelpout *Lycodes vahlii*, Norwegian topknot *Phrynorhombus norvegicus*, yellow sole *Buglossidium luteum*, Atlantic goby *Pomatoschistus spec.*, gurnard *Chelidonichthys spec.*, snailfish *Liparis spec.*, snake pipefish *Entelurus aequoreus* and pipefish *Syngnathus spec.*) which may, however, occur in the bycatch.

Other marine species occur regularly in the North Sea as what are known as "summer guests", mainly in summer, but with no clear signs of reproduction. Examples are the tub gurnard *Chelidonichthys lucernus* and the striped red mullet *Mullus surmuletus*. However, very small juveniles of these two species have been detected recently, which suggests reproduction in the area (HEESSEN 2015, DÄNHARDT 2017).

Some species occur irregularly in the North Sea, regardless of the season, including rabbit fish *Chimaera monstrosa*, Atlantic pomfret *Brama brama*, witch flounder *Glyptocephalus cynoglossus* and Atlantic halibut *Hippoglossus hippoglossus*. Usually only single individuals of these and other "vagrant" species, as they are known, are caught.

In contrast to the marine fish of the above three categories, the life cycle of diadromous species spans both seawater and freshwater. As the only catadromous species found in the German EEZ, the European eel *Anguilla anguilla* spawns in the sea and lives most of its adult life in freshwater or brackish water. Anadromous species that spawn in freshwater and otherwise live in the sea are much more common. Examples of such fish in the EEZ include smelt *Osmerus eperlanus*, twait shad *Alosa fallax*, Atlantic salmon *Salmo salar*, brown trout *Salmo trutta*, houting *Coregonus oxyrhynchus*, European river lamprey *Lamptera fluviatilis* and sea lamprey *Petromyzon marinus*, as well as the now extinct European sea sturgeon *Acipenser sturio*

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

About 6600 fishing vessels operate in the North Sea, with an annual catch of approximately 2 million tonnes per annum across species and populations (ICES 2017a). Landings of pelagic species such as Atlantic herring and Atlantic mackerel far exceed catches of demersal fish such as sand eel and haddock, bycatches from demersal fishing being much larger than bycatches from pelagic fishing. Almost all fishing operations catch more than one target species, so management measures for one species automatically affect other species as well. The greatest physical disturbance of the seabed is caused by bottom contact tackle in the English Channel, the southeastern North Sea and the central Skagerrak, and all fishing operations end up catching bycatch species that are protected and/or endangered (THIEL et al. 2013, IUCN 2014).

The German fishing fleet in the North Sea consists of more than 200 fishing vessels, of which the 180 shrimping boats in the southeastern North Sea make up the largest component. Six large beam trawlers catch saithe *Pollachius virens* in the northern North Sea, while some medium-sized vessels catch saithe, Atlantic cod, common sole and European plaice with trawl board nets and beam trawls. Fewer than ten ships are involved in pelagic and industrial fishing for herring, Atlantic horse mackerel, Atlantic mackerel, sprat and sand eel (ICES 2017a).

2.7.1 Data availability

As data is almost only available from demersal fishing, but not from sampling in the pelagic zone, the following assessment can only take place for demersal fish. No reliable estimations are possible for pelagic fish. The assessment of the condition of the protected asset (demersal) Fish is based on

- the analyses of the R&D project "Bewertungsansätze für Raumordnung und Genehmigungsverfahren im Hinblick auf das benthische System und Habitatstrukturen" [Evaluation 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 studies for compilation of up-to-date species lists (areas N-1 to N-8 only).
- the International Council for the Exploration of the Sea (ICES) Database of Trawl Surveys (DATRAS) (accessed on 12 marts 2018). Only the standard areas and grid squares covering the German North Sea EEZ were considered. These are the grid squares 37F6, 38F5-F8, 39F5 and 40F4-F7 in standard roundfish area 6. The catch data from the first and third quarters of the most recent year (2017) has been summarised. Data from the first quarter

was already available for 2018, and this was combined with data from the third quarter of 2017.

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

2.7.2 Spatial distribution and temporal variability

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

2.7.2.1 Red List species in the German North Sea area

The threat to the 107 fish and lamprey species established in the North Sea was assessed within the scope of the Red List based on the current population situation and long-term and short-term population trends (THIEL et al. 2013). Accordingly, 23.4% (25 species) of the marine fish and lampreys established in the North Sea are classified as extinct or endangered. Taking into account the extremely rare species, the proportion of Red List species increases to 27.1% (29 species). Five of these species (shad, twait shad, houting, European river lamprey and sea lamprey) are also listed in Annex II of the Habitats Directive.

DANNHEIM et al. (2014) derived "Bewertungsansätze für Raumordnung und Genehmigungsverfahren im Hinblick auf das benthische System und Habitatstrukturen" [Evaluation 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 at the Alfred Wegener Institute for Polar and Marine Research within the scope of a research and development project. According to the study, 15 of the 89 fish species analysed (16.9%) had a Red List threat status: allice shad, thornback ray and spiny dogfish are threatened with extinction (category 1), European eel, school shark and haddock are considered critically endangered (category 2), while twait shad, starry ray, European river lamprey, greater weever and poor cod are endangered (category 3). The authors identified an indeterminate threat (category G) to the snake pipefish, the ling and the great pipefish, and the Ballan wrasse is extremely rare (category R).

2.7.2.2 Typical regional fish communities in the EEZ

In May 2002, KLOPPMANN et al. (2003) identified a total of 39 fish species as part of a one-off study for the purposes of recording of Habitats Directive Annex II fish species in the areas of Borkum Reef Ground, Amrum Outer Ground, Eastern Slope of Elbe-Urstromtal Valley and Dogger Bank in the German EEZ. This study identified a gradual change in the species composition of fish communities from coastal to offshore areas due to hydrographic conditions. These changes were confirmed by DANNHEIM et al. (2014), who were able to identify four geographically distinct fish communities in the German EEZ based on catch figures corrected for complexity: the largest was the Central Community (ZG), which could be demarcated in the north by the two Entenschnabel communities (ES I and ES II) and along the coast by a Coastal Community (KG) (Figure 21 and Figure 22). Areas with fewer than six stations were not allocated to any fish community (grey symbols in Figure 21).

The four fish communities identified essentially had a similar species composition, but with different species-specific abundances. Common dab dominated generally and occurred at very regular intervals, while European plaice and American plaice dominated in the ES II offshore community. European plaice were also found regularly in the central transitional community. Dragonet (*Callionymus spp.*), yellow sole (*Buglossidium luteum*) and hooknose (*Agonus cataphractus*) were characteristic of the coastal community of demersal fish. Yellow sole and dragonet were also found regularly in the central transitional community. The species composition and distribution of demersal fish showed gradual changes from offshore to coastal areas via the central community. The number of species in the ES I community was significantly lower (ES I: 2 ± 1 * Hol^{-1}) than in the other communities, with an average species number of 6 ± 2 Hol^{-1} (ES II) or 7 ± 2 * Hol^{-1} (KG).

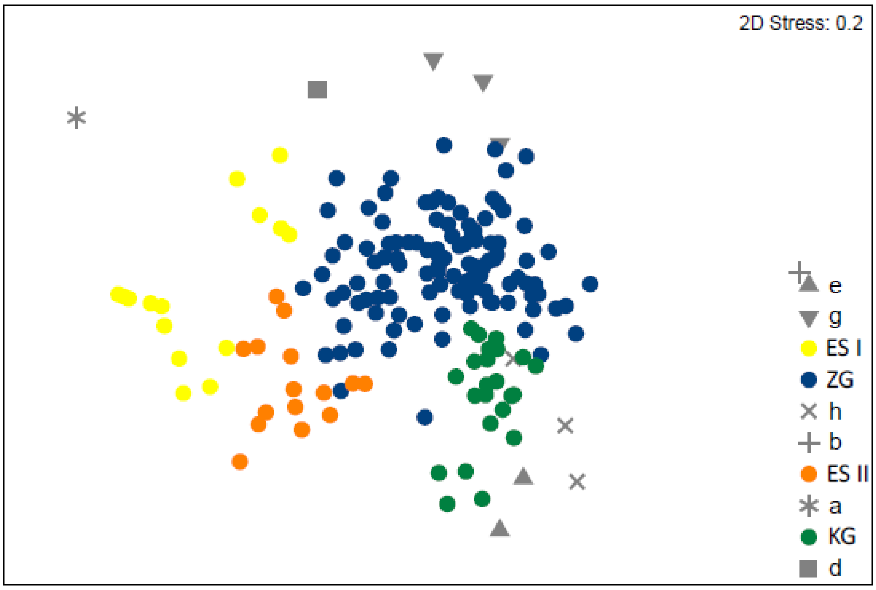


Figure 21: Relative similarity of species composition and species-specific abundances of demersal fish in the German North Sea EEZ. The central community (ZG, blue dots), the coastal community (KG, green dots) and two Entenschnabel communities (ES I and II, yellow and orange dots) can be clearly distinguished from one another. Areas with fewer than six stations were not allocated to any fish community (grey symbols e, g, h, b

and d). Non-metric multidimensional scaling based on √-transformed and standardised-complexity abundance data from catches with a 2 m beam trawl (RACHOR & NEHMER (2000) and BENDER (2014); N = 173 stations). From DANNHEIM et al. (2014).

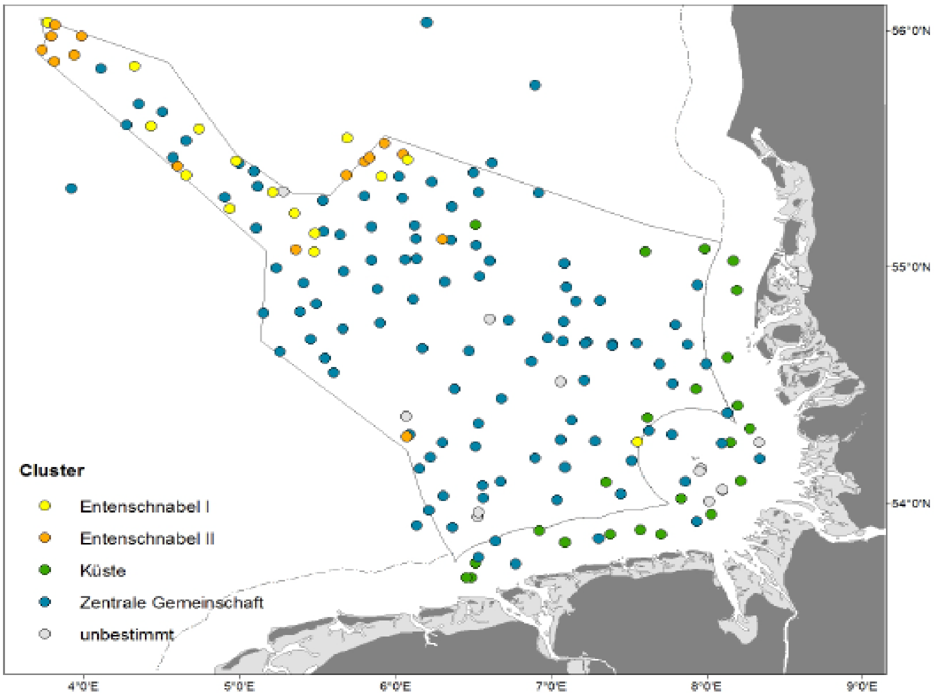


Figure 22: Map of the spatial variability of the fish communities of the German North Sea EEZ based on abundance data corrected for complexity. Abbreviations, analysis methods, colour codes and sample sizes as in Figure 21. From DANNHEIM et al. (2014).

As well as the number of species, the abundance of demersal fish close to the coast increased 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 23a). The biomass, on the other hand, did not show a directed geographical progression and the lowest biomass was found in ES I (108 ± 112 kg * km^{-2}). The largest biomass, 801 ± 513 kg * km^{-2}, was found in ES II (Figure 23b).

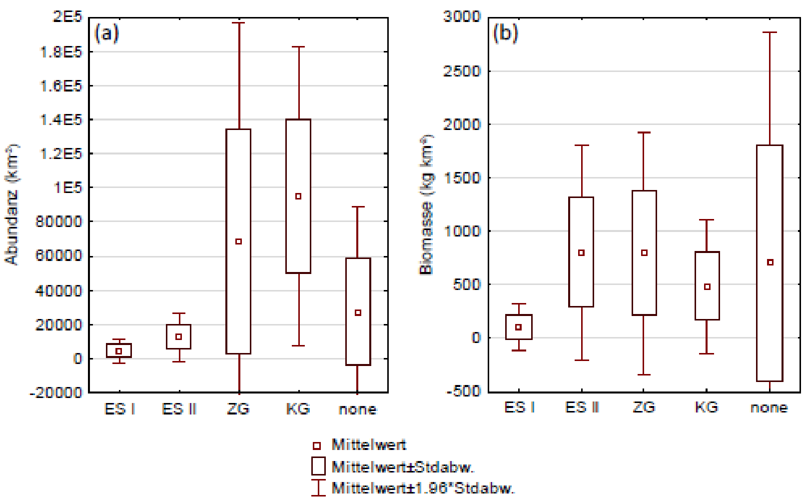


Figure 23: Box plots of (a) abundance (individuals * km^{-2}) and (b) biomass (kg * km^{-2}) of the fish communities identified in the German North Sea EEZ. Abbreviations, analysis methods and sample sizes as in Figure 21. From DANNHEIM et al. (2014).

Using 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 was grouped according to wind farm clusters as defined in the Spatial Offshore Grid Plan (Federal Maritime and Hydrographic Agency 2017). These wind farm areas will be referred to below in numerical terms as OWF areas 1-12 in accordance with the Site Development Plan (Figure 24 below). To exclude temporal effects on the spatial analyses, data from all OWF areas was evaluated in pairs, according to year and season (Figure 24 top left). The individual OWF areas were compared with one another in pairs by means of simple analyses of similarity (ANOSIM), the mean R value being calculated as a measure of the mean dissimilarity between predefined groups (here: the OWF areas). R values near 0 indicate a lack of differences, R values near 0.25 indicate that it is almost impossible to separate groups, R values near 0.50 indicate that group separation is possible, R values near 0.75 indicate good group separability, while – finally – R values near 1.00 indicate complete group separation (CLARKE & GORLEY 2001). Without the influence of temporal effects, western OWF areas 1 and 2 (SW-W DB) could be separated from eastern OWF area 3 (SW-O DB) in the southwest German Bight off the East Frisian coast (Figure 24). Furthermore, the analyses showed separation of the coastal OWF areas 4 (S EUT) and 5 (N EUT) along the edge of the Elbe-Urstromtal Valley. The greatest similarity (characterised by low R values) in terms of species-specific fish abundance existed between OWF areas 6 to 12 in the northwest German Bight (NW DB).

The differences between the five geo-clusters identified by ANOSIM (SW-W DB, SW-O DB, N EUT, S EUT, NW DB; Figure 24) were clearly apparent, although the degree of dissimilarity between adjacent geo-clusters also varied considerably. While OWF areas 5 and 6 were very similar (mean R value = 0.42), the fish community of OWF area 12 differed significantly from that of OWF area 10 within geo-cluster NW DB (R = 0.84) (Figure 24 top left). The separation of the geo-clusters based on species-specific abundance is therefore to be understood more as a spatial gradient in the community area than as a sharp demarcation of different demersal fish communities. The number of species of demersal fish was basically very similar between the geo-clusters: in geo-cluster SW-W DB, most species (13 ± 3) were caught by haul on average, while the fewest fish species (11 ± 3) were caught by haul in geo-cluster N EUT. Moreover, the geo-clusters did not indicate geographically clear differences in terms of total abundance and total biomass of all species. The highest abundance was recorded in geo-cluster SW-O DB (82,040 ± 70,335 individuals * km^{-2}), the lowest in geo-cluster NW DB (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). Even species composition hardly differed between the geo-clusters: more than 60% of species occurred across areas. Only five species were of relevance to the dissimilarity between the geo-clusters. Yellow sole, common dab and European plaice were present in all geo-clusters, but they contributed to the similarity to varying degrees. Scaldfish (*Arnoglossus laterna*) were characteristic of the western geo-clusters (SW-W DB, SW-O DB, NW DB), while Atlantic gobies (*Pomatoschistus spp.*) characterised the geo-clusters along the Elbe-Urstromtal Valley and eastern areas (N EUT, S EUT). There are hardly any structural differences in the species composition between the geo-clusters. Differences are based solely on the different abundances of the species.

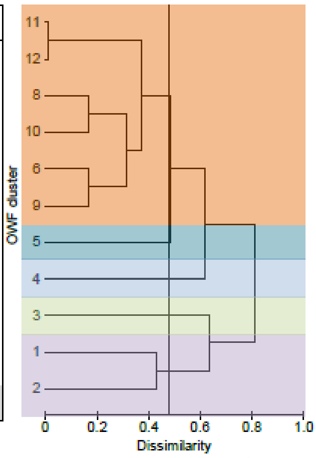
2.7.3 Status assessment of the factor Fish

The assessment of the condition of the demersal fish community of the German North Sea EEZ is based on i) rarity and vulnerability, ii) diversity and singularity, and iii) naturalness. These three criteria are defined below and applied separately for areas 1-3, area 4, area 5, areas 6-8 and areas 9-13.

Rareness and vulnerability

The rarity and vulnerability of the fish community is assessed based on the proportion of species that are considered endangered according to the current Red List of Marine Fishes (THIEL et al. 2013) and for the diadromous species of the Red List of Freshwater Fishes (FREYHOF 2009) and have been assigned to one of the following Red List categories: extinct or disappeared (0), threatened with extinction (1), critically endangered (2), endangered (3), indeterminate (G), extremely rare (R), Early Warning List (V), data deficient (D) or of least concern (*) (THIEL et al. 2013). Particular attention must be paid to the threat to species listed in Annex II of the Habitats Directive. Europe-wide protection efforts are being focused on these, and they require special protection measures, e.g. for their habitats. The John Dory (= Peter's fish) *Zeus faber* was not assessed in the current Red List of Marine Fishes (THIEL et al. 2013).

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											



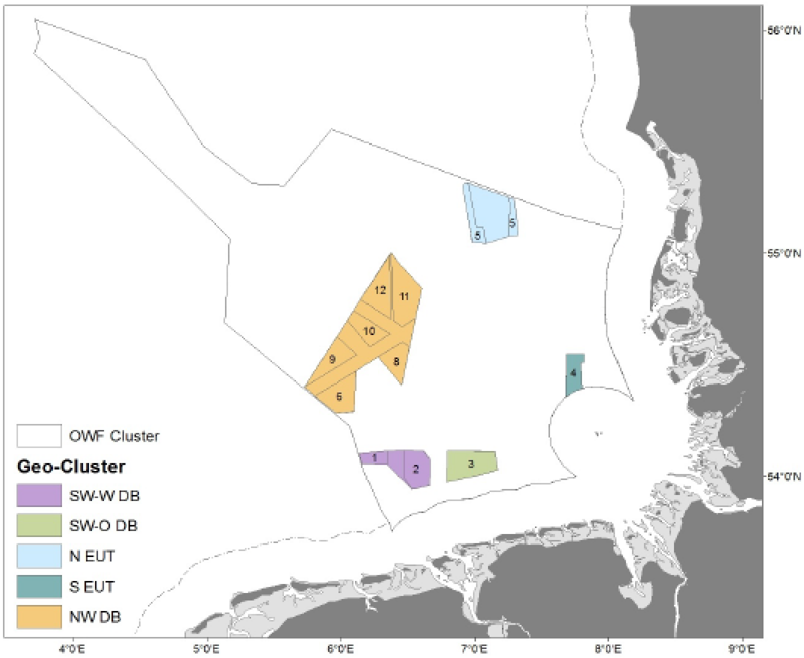


Figure 24: Top: R values for the diversity of the OWF areas (one-factor ANOSIM) based on demersal fish abundance data. The R values correspond to the mean R value of the individual paired tests between the OWF areas. Top: Differences between the identified geo-clusters, in different colours. Bottom: Map of the OWF areas (numbers) and location of the geo-clusters identified from the R values (one-factor ANOSIM) (colours, see map legend). SW-W DB: Western Southwest German Bight, SW-O: Eastern Southwest German Bight, N EUT: Northern Elbe-Urstromtal Valley, S EUT: Southern Elbe-Urstromtal Valley, NW DB: Northwest German Bight. From DANNHEIM et al. (2014).

In the sea territories in which **areas 1, 2 and 3** are located, a total of 37 fish species were identified during the environmental impact assessments in the above period (2.8.1) and within the framework of fish monitoring for population assessment. According to THIEL et al. (2013), no species was identified as extinct or disappeared (0), the thornback ray *Raja clavata* (1 species, 2.7%) is threatened with extinction (1), and no critically endangered species (2) were identified. The greater weever *Trachinus draco* is considered endangered (3) (1 species, 2.7%), for the great pipefish *Syngnathus acus* and the snake pipefish *Entelurus aequoreus* an indeterminate threat (G) is assumed (2 species, 5.4%). None of the species found in areas 1-3 is extremely rare (R), while Atlantic mackerel *Scomber scombrus*, turbot *Scophthalmus* *maximus* and common sole *Solea solea* are on the Early Warning List (3 species, 8.1%). There is considered to be insufficient data (D) for the Raitt's sand eel *Ammodytes marinus*, the reticulated dragonet *Callionymus reticulatus*, the greater sand eel *Hyperoplus lanceolatus*, the painted goby *Pomatoschistus pictus* and the longspined bullhead *Taurulus bubalis* (5 species, 13.5%). Of the 37 species included, 25 (67.6%) are considered to be of least concern (*), including the three-spined stickleback *Gasterosteus aculeatus*, which has been included in the Red List of Freshwater Fishes (FREYHOF 2009) (Figure 25).

In the sea areas where **area 4** is located, a total of 37 species were identified during the environmental impact assessments and within the scope of fish monitoring for population assessment purposes. According to THIEL et al. (2013), none of these species is considered to be extinct or disappeared (0), threatened with extinction or critically endangered (2). One species, the starry ray *Amblyraja radiata*, is considered endangered (3) (1 species, 2.7%), the snake pipefish *Entelurus aequoreus* is subject to an indeterminate threat (G) (1 species, 2.7%), while the smelt *Osmerus eperlanus* (assessed in FREYHOF 2009), Atlantic mackerel *Scomber scombrus*, turbot *Scophthalmus maximus* and common sole *Solea solea* are on the Early Warning List (4 species, 10.8%). There is insufficient data available for an assessment (D) for a further three species (8.1%), the Raitt's sand eel *Ammodytes marinus*, the reticulated dragonet *Callionymus reticulatus* and the greater sand eel *Hyperoplus lanceolatus*. 28 species (75.7%) are considered to be of least concern (*) (Figure 25).

During the environmental impact assessments and fish monitoring for population assessment purposes, a total of 35 species have been identified in the sea territory in which **area 5** is located. According to THIEL et al. (2013), no species is defined as extinct or disappeared (0), threatened with extinction (1), critically endangered (2) or extremely rare (R). Likewise, none of the species found in area 5 are endangered to an indeterminate extent (G). FREYHOF (2009) assessed the European river lamprey *Lampetra fluviatilis* to be endangered (3) (2.9%), while Atlantic mackerel *Scomber scombrus*, turbot *Scophthalmus maximus* and common sole *Solea solea* (3 species, 8.6%) are on the Early Warning List, as are the areas already discussed. The data situation for the Raitt's sand eel *Ammodytes marinus*, the lesser sand eel *Ammodytes tobianus*, the reticulated dragonet *Callionymus reticulatus* and the greater sand eel *Hyperoplus lanceolatus* is considered deficient, and 27 species (77.1%) are considered to be of least concern (*) (Figure 25).

During the environmental impact assessments and fish monitoring for population assessment purposes, a total of 39 species have been identified in the sea territories in which **areas 6-8** are located. According to THIEL et al. (2013) no species was identified as extinct or disappeared (0), the thornback ray *Raja clavata* (1 species, 2.6%) is threatened with extinction (1). The European eel *Anguilla anguilla* and the school shark *Galeorhinus galeus* (2 species, 5.1%) are critically endangered (2), the starry ray *Amblyraja radiata* and the twait shad *Alosa fallax* are considered endangered (3) (2 species, 5.1%), while the great pipefish *Syngnathus acus* is considered to be subject to an indeterminate threat (G) (1 species, 2.6%). The spotted ray *Raja montagui* (1 species, 2.6%) is extremely rare (R), the Atlantic mackerel *Scomber scombrus*, the turbot *Scophthalmus maximus* and the common sole *Solea solea* are on the Early Warning List (V) (3 species, 7.7%). The available data for an assessment is insufficient (D) for the Raitt's sand eel *Ammodytes marinus* and the greater sand eel *Hyperoplus lanceolatus* (2 species, 5.1%).

27 species, 69.2%, are considered to be of least concern (*) (Figure 25).

No environmental impact assessments have been carried out as yet in the sea territories where **areas 9-13** are located. Therefore, the assessment is based solely on fish monitoring data for population assessment, i.e. on a lower number of hauls, which may influence the number of species. A total of 29 species have been identified in areas 9-13, of which none is considered extinct or disappeared (0), critically endangered (2), extremely rare (R) or subject to an indeterminate threat (G) according to THIEL et al. (2013). The spiny dogfish *Squalus acanthias* is threatened with extinction (1) (1 species, 3.4%), the starry ray *Amblyraja radiata* is considered endangered (3) (1 species, 3.4%). As in all other clusters considered, the Atlantic mackerel *Scomber scombrus*, the turbot *Scophthalmus maximus* and the common sole *Solea solea* are on the Early Warning List (3 species, 10.3%). The available data for an assessment is insufficient (D) for the Raitt's sand eel *Ammodytes marinus*, the greater sand eel *Hyperoplus lanceolatus* and the European hake *Merluccius merluccius* (3 species, 13.8%). 20 species (69%) are considered to be of least concern (*) (Figure 25).

	Red List category								
AREA	**0**	**1**	**2**	**3**	**G**	**R**	**V**	**D**	*****
1-3	0.0	2.7	0.0	2.7	5.4	0.0	8.1	13.5	67.6
4	0.0	0.0	0.0	2.7	2.7	0.0	10.8	8.1	75.7
5	0.0	0.0	0.0	2.9	0.0	0.0	8.6	11.4	77.1
6-8	0.0	2.6	5.1	5.1	2.6	2.6	7.7	5.1	69.2
9-13	0.0	3.4	0.0	3.4	0.0	0.0	10.3	13.8	69.0
Red List	**2.8**	**7.5**	**6.5**	**1.9**	**4.7**	**3.7**	**6.5**	**22.4**	**43.9**

Figure 25: Relative percentages of Red List categories among fish species detected in areas 1-3, 4, 5, 6-8 and 9-13. Extinct or disappeared (0), threatened with extinction (1), critically endangered (2), endangered (3), indeterminate (G), extremely rare (R), Early Warning List (V), data deficient (D) or least concern (*) (Thiel et al. 2013). (EIS data from 2014 onwards for clusters 1-8 and data from 2017/2018 from the ICES DATRAS database, see 2.8.1). The relative percentages of the assessment categories in the North Sea Red List (Thiel et al. 2013) are shown by way of comparison.

In the Red List of Marine Fishes, 27.1% of the species assessed were assigned to a threat category (0, 1, 2, 3, G or R), 6.5% were on the Early Warning List, and 22.4% could not be assessed due to a lack of data. A total of 43.9% of species are considered to be of least concern (THIEL et al. 2013) (Figure 25). By way of comparison, significantly fewer species with a threat status were found in all the clusters considered (1-3: 10.8%, 4: 5.4%, 5: 2.9%, 6-8: 18.0%, 9-13: 6.8%), while considerably more species deemed to be of least concern were always found than were named in the Red List (1-3: 67.6%, 4: 75.7%, 5: 77.1%, 6-8: 69.2%, 9-13: 69.0%).

Extinct or disappeared species (category 0) were not identified in any of the areas. The significance of the areas is below average for endangered (1) and critically endangered (2) species, while endangered species (3) were relatively more frequent in all areas than in the Red List. The areas are of above-average importance for these species. A higher proportion of category G species (indeterminate threat) was found in areas 1-3, otherwise their relative percentage, as well as that of extremely rare species (R), was below the Red List. A relatively larger number of species of categories V (Early Warning List) and * (least concern) was found in all areas, which are therefore of above-average importance for species of these two categories. The proportion of species (D) that could not be assessed due to insufficient data was significantly lower in all areas than the proportion of this category in the Red List (Figure 25).

A total of two FFH species were identified in the twait shad *Alosa fallax* (areas 6-8) and the European river lamprey *Lampetra fluviatilis* (area 5), as well as species protected pursuant to the protected area regulations for "Sylt Outer Reef – Eastern German Bight", but as individual catches; hence the significance of these areas for the species cannot be derived from this information.

Against this background, the overall assessment of the Spatial Offshore Grid Plan (Federal Maritime and Hydrographic Agency 2017) is that the fish fauna of the areas under consideration is to be regarded as average to above average in terms of the criteria of rarity and vulnerability.

Diversity and uniqueness

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

Over 200 fish species have been identified in the North Sea to date (YANG 1982, DAAN 1990: 224, LOZAN 1990: > 200, FRICKE et al. 1994, 1995, 1996: 216, WWW.FISHBASE.ORG: 209; status: 24 February 2017), the vast majority of which are rare single identifications. Fewer than half of these reproduce regularly in the German Exclusive Economic Zone (EEZ) or are found as larvae, juveniles 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) identified 99 fish species throughout the North Sea between 2014 and 2018. A total of 56 species were identified in the German EEZ, represented here by the area-specific fish data from environmental impact studies (from 2014) and the ICES DATRAS database (IBTS data 2017 and 2018). With the exception of areas 9-13, the number of species in the individual areas was between 35 and 39 (see "Rarity and vulnerability"). Most species were found in areas 6-8, followed by areas 4, 1-3 and 5. Only 29 species have been identified in areas 9-13 in zone 3 (Figure 26), but this may be at least partly due to the reduced effort to record data in this area.

All typical demersal flatfish and roundfish species have been found in all areas. The constant and characteristic flatfish species scaldfish *Arnoglossus laterna*, yellow sole *Buglossidium luteum*, common dab *Limanda limanda*, lemon sole *Microstomus kitt*, European plaice *Pleuronectes platessa*, turbot *Scophthalmus maximus*, brill *Scophthalmus rhombus* and common sole *Solea solea* were present in all areas taken into consideration. There were catches of European flounder *Platichthys flesus* in 4 out of 5 areas despite their coastal and estuarine affinity (Figure 26).

Although the bottom trawls used are unsuitable for catching pelagic fish, the species typical of the pelagic part of the fish community were identified in all areas (Figure 26): Raitt's sand eel *Ammodytes marinus*, Atlantic herring *Clupea harengus*, greater sand eel *Hyperoplus lanceolatus*, Atlantic mackerel *Scomber scombrus*, European sprat *Sprattus sprattus* and Atlantic horse mackerel *Trachurus trachurus*.

		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**

Figure 26: Total species list for fish in the German North Sea EEZ and species identified in areas 1-3, 4, 5, 6-8 and 9-13 (EIS data from 2014 onwards for areas 1-8, and data from 2017/2018 from the ICES DATRAS database).

Of the 56 species found in the German EEZ during the period under consideration, only 19 species were found in all areas, 10 species were found in four areas, 5 species were found in three areas, 6 species were found in only two areas (Figure 26). The remaining 16 species were each caught in only one area, with anadromous species such as twait shad *Alosa fallax*, European river lamprey *Lampetra fluviatilis* or smelt *Osmerus eperlanus*, coastal species such as three-spined stickleback *Gasterosteus aculeatus*, European flounder *Platichthys flesus*, or gobies of the genus *Pomatoschistus*, or species dependent on coastal habitats (seagrass meadows), such as the lesser pipefish *Sygnathus rostellatus*, being found in the coastal clusters, as expected. These species were absent in the offshore areas (areas 9-13). However, European hake *Merluccius merluccius* and spiny dogfish *Squalus acanthias* were caught solely in offshore areas (Figure 26).

The composition of fish species appears to differ between areas in terms of individual, rare species (e.g. sharks and rays), while there are great similarities in the case of the more characteristic, more abundant species (Figure 26).

Between 1982 and 2002, EHRICH et al. (2006) identified 104 fish species in the North Sea, and KLOPPMANN et al. (2003) found 39 species with significantly less recording effort and a shorter recording period. Compared with these reports and the data from the North Sea as a whole, the diversity in all areas can be regarded as average in line with the assessment of the Spatial Offshore Grid Plan 2016/2017 (Federal Maritime and Hydrographic Agency 2017). The typical and characteristic species of both the pelagic and demersal components of the fish communities considered were also present in all areas (see above). The characteristics of the fish communities found are thus also deemed to be average.

Naturalness

The naturalness of a fish community is defined as the absence of anthropogenic influences, of which fishing has the greatest impact. Certainly, fish are also subject to other direct or indirect human influences, such as eutrophication, shipping, pollutants and sand and gravel extraction. However, these effects cannot be measured reliably as yet. In principle, the relative effects of the individual anthropogenic factors on the fish community and their interactions with natural biotic (predators, prey, competitors, reproduction) and abiotic (hydrography, meteorology, sediment dynamics) influencing variables of the German EEZ cannot be separated reliably. However, the removal of target species and bycatch, as well as the degradation of the seabed in the case of ground-breaking fishing methods, make fisheries the most effective disturbance of the fish community. It is therefore used as a measure of the naturalness of the fish communities in the North Sea and Baltic Sea. The stocks are not assessed on a smaller spatial scale such as the German Bight. Consequently, this criterion cannot be assessed at area level, but only for the North Sea as a whole.

Of the 107 species considered established in the North Sea, 21 are fished commercially (THIEL et al. 2013). The assessment of naturalness is based on "Fisheries overview – Greater North Sea Ecoregion" of the International Council for the Exploration of the Sea (ICES 2017a). Fishing impacts on the ecosystem in two primary ways: disturbance or destruction of benthic habitats by bottom contact nets, and removal of target species and bycatch species. The latter often includes protected, endangered or threatened species, including reptiles, birds and mammals in addition to fish (ICES 2017c). Some 6600 fishing vessels from 9 nations fish in the North Sea. The largest quantities were landed in the early 1970s, and catches have declined since then. However, a reduction in fishing effort has only been observed since 2003. The profits of many fishing fleets have increased recently due to the improved condition of many fish populations, smaller fleets, lower fuel costs and more efficient fishing equipment.

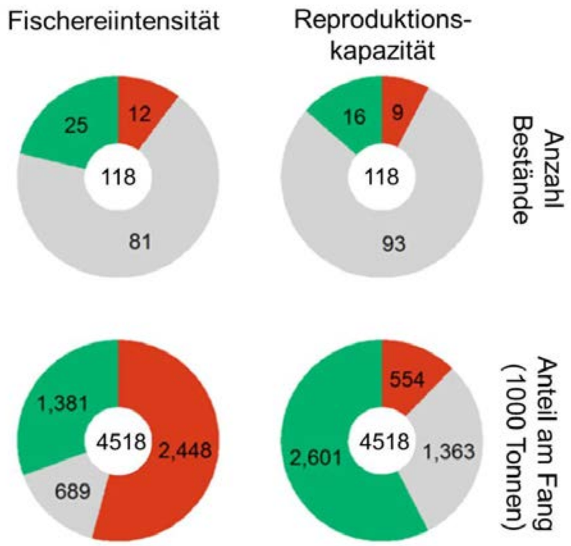


Figure 27: Summary of the status of fish populations in the North Sea, 2017. Left: The fishing intensity indicates the number of populations (above) and the biomass percentage of the catch (below; in 1000 tonnes) below (green) or above (red) the reference value (FMSY, fishing mortality consistent with achieving maximum sustainable yield). Right: Reproductive capacity is the number of populations (above) and the biomass percentage of the catch (below) above (green) or below (red) the reference - value (spawning stock biomass, MSY Btrigger). Grey indicates the number or biomass percentage of the catch among populations for which no reference points are defined and for which it is therefore not possible to estimate the population. A total of 118 populations were taken into consideration, which jointly provided 4,518,000 tonnes of catch. Amended according to ICES (2017c).

The intensity of bottom contact fishing is concentrated in the southern North Sea and is also by far the dominant form of fishing in the German EEZ (ICES 2017a). The German fleet comprises more than 200 fishing vessels, of which 180 are shrimping boats operating mainly in coastal waters. Bottom contact fishing for flatfish in the German EEZ is predominantly not conducted by German vessels. This fishing targets European plaice and common sole, using not only heavy ground tackle but also relatively small meshes, which potentially results in very high bycatch rates for small fish and other marine animals.

Commercial fishing and the size of spawning stocks are assessed against the Maximum Sustainable Yield (MSY), taking into account the precautionary approach. A total of 118 populations were taken into consideration in terms of fishing intensity, of which 37 were scientifically assessed but 81 were not. Of the 37 populations assessed, 25 are managed sustainably (Figure 26; ICES 2017c). Twenty-five of the 118 populations were assessed for their reproductive capacity (spawning stock biomass). Sixteen of these have full reproductive capacity (Figure 27; ICES 2017c).

The biomass percentage in the total North Sea catch (4,518,000 tonnes in 2017) of stocks managed at too high a fishing intensity outweighs the percentage of sustainably caught populations that have not been assessed (Figure 27). That said, fish from populations account for the predominant biomass percentage of the catch where the reproductive capacity is above the defined reference levels, followed by unassessed populations and populations where the reproductive potential is below the reference level (Figure 27).

Overall, fishing mortality rates for demersal and pelagic fish have decreased significantly since the late 1990s, and for most of these populations spawning stock biomass has been increasing since 2000 and is now above or close to individually established reference points. Nevertheless, the fishing mortality rate for many populations is also above the reference levels established, e.g. for Atlantic cod, whiting, haddock, Atlantic mackerel and blue whiting, and no reference values have been defined for the majority of the populations fished; hence scientific assessment of the populations is not possible (Figure 26).

In the overview of key fishing figures (ICES 2017c) and the ecosystem effects of bottom contact fishing (WATLING & NORSE 1998, HIDDINK et al. 2006) which predominates in the North Sea and the German EEZ, the naturalness of the fish fauna is classified as average as in the Spatial Offshore Grid Plan 2016/2017 (Federal Maritime and Hydrographic Agency 2017).

2.7.3.1 Importance of areas and sites for fish

The primary criterion for the importance of the areas and sites for fish is the relationship to the life cycle, within which various stations are linked with stage-specific habitat requirements via more or less extensive migrations in the interim. Information on the reproductive status was not collected in any of the datasets used, so the significance of the areas and sites for fish can only be described in general terms. Moreover, the fact that the catch data used was collected using methods that do not allow habitat references to be derived impedes precise assessment of the area. The overview of the - species records by area showed no particular importance of a specific area (Figure 26) for the constant, frequent characteristic species. However, there is a tendency for the coastal areas to host more species. This could in fact be an artefact of the different numbers of hauls, but an overlap between the habitat of coastal fish species and the existing and future wind farm sites is plausible, given the background of the mobile way of life and the life cycle of most species. The higher proportion of coastal species in the coastal areas could therefore be an indication of the higher importance of areas 1-3, area 4 and area 5 for coastal fish such as gunnel, smelt and pipefish compared with the offshore areas. These areas are also located along the migratory route used by Atlantic herring, which are spawned along the east coast of Great Britain in autumn and winter and only reach the coastal nursery areas with the counterclockwise residual current of the North Sea (DICKEY-COLLAS et al. 2009), from where they also recruit to the adult population along the coast as annual or biennial fish. European plaice spawned in the central North Sea migrate to their nursery growth on the coast (BOLLE et al. 2009), crossing all the areas considered here, which may therefore be significant as transit areas for one of the most common fish species in the North Sea. The fact that spiny dogfish were caught only in areas 9-13 may not be sufficient as yet to determine the special significance of these areas for this species, as spiny dogfish also occur on the coast. Slightly higher proportions of species threatened with extinction, critically endangered, endangered and endangered to an indeterminate extent were found in areas 6-8 than in other areas, which were also above the average found in the Red List. For these species, this area could be more important than other areas where evidence is unavailable.

2.8 Marine mammals

Three marine mammal species are found regularly in the German North Sea EEZ: the harbour porpoise (*Phocoena phocoena*), the grey seal (*Halichoerus grypus*) and the harbour seal (*Phoca vitulina*). All three types are characterised by high levels of mobility. Migration (especially for the purpose of searching for food) is not limited to the EEZ, but also includes coastal waters and large transboundary areas of the North Sea.

Resting and breeding grounds for the two seal species are found on islands and sandbanks in the area around coastal waters. They undertake extensive migrations in the open sea from their resting grounds in order to hunt for food. Due to the high mobility of marine mammals and the use of very extensive areas, it is necessary to consider their occurrence not only in the German EEZ, but in the whole area of the southern North Sea.

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

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

2.8.1 Data availability

The three SCANS studies (Small Cetacean Abundance in the North Sea and adjacent waters), which cover the entire North Sea, Skagerrak, Kattegat, western Baltic Sea/Beltsee, Celtic Sea and other parts of the northeastern Atlantic, are the most important large-scale studies.

German waters are currently among the areas of the North Sea that have been systematically and very intensively investigated for the occurrence of marine mammals since 2000. Most of the data is provided by surveys carried out within the scope of environmental impact studies and construction and operation monitoring for offshore wind farms. Regular surveys for the monitoring of Natura 2000 sites are also carried out on behalf of the BfN. Data is also collected within the scope of research projects investigating specific issues.

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

The current findings relate to different spatial levels:

- the entire North Sea and adjacent waters: SCANS I, II and III studies carried out in 1994, 2005 and 2016,
- Research projects in the German EEZ and coastal waters (including MINOS, MINOSplus (2002 – 2006) and StUKplus (2008 – 2012)),
- Surveys to fulfil the requirements of the Environmental Impact Assessment Act within the framework of Federal Maritime and Hydrographic Agency approval and planning permission procedures, and also from construction and operation monitoring of offshore wind farms since 2001,
- Monitoring of Natura 2000 sites on behalf of the BfN since 2008.

For the German EEZ area, the most comprehensive data is collected in the context of environmental impact studies and construction and operation monitoring of offshore wind farms. Marine mammals are recorded both from the ship and from the aircraft in this regard. With the introduction of the StUK4 standard, data is recorded with the aid of high-resolution digital photos or video technology.

Moreover, acoustic data on habitat use by harbour porpoises has been recorded continuously since 2009 using underwater measurement systems such as C-PODs or SM2M / SM3M. Operators of offshore wind farms have maintained a C-PODs station network in the German EEZ since 2009. This station network provides the most comprehensive and valuable data to date on the habitat use of harbour porpoises in the territories of the German North Sea EEZ.

Current knowledge is gained from the monitoring of offshore projects in areas N-1, N-2 and N-3 (research cluster Northern Borkum), area N-4 (research cluster Northern Helgoland), and from individual projects in areas N-5 and N-6 to N-8. The results from construction and operation monitoring of offshore wind farms thus provide extensive, high-resolution data on the occurrence of marine mammals in terms of both space and time.

Harbour porpoises occur all year round in the German North Sea EEZ, but concentrations in their occurrence and spatial distribution are apparent depending on the season.

The large-scale distribution and abundance in the German EEZ is surveyed as part of the monitoring of Natura 2000 sites on behalf of the BfN (monitoring reports for 2008, 2009, 2011, 2012, 2013, 2016 on behalf of the BfN).

2.8.2 Spatial distribution and temporal variability

The high mobility of marine mammals, depending on particular conditions in the marine environment, leads to high spatial and temporal variability in their occurrence. Both the distribution and the abundance of the animals vary throughout the seasons. Large-scale, long-term studies are particularly necessary so as to be able to draw conclusions about seasonal distribution patterns and the use of areas and sites, as well as the effects of seasonal and interannual variability.

2.8.2.1 Harbour porpoise

The harbour porpoise (*Phocoena phocoena*) is a common species of whale in the temperate waters of the North Atlantic and North Pacific, as well as in some intracontinental seas such as the North Sea. The distribution of the harbour porpoise is limited to continental shelf seas due to its hunting and diving behaviour (READ 1999). These animals are extremely mobile and can cover large distances in a short time. It has been established with the aid of satellite telemetry that harbour porpoises can travel up to 58 km in a day. The tagged animals behaved very individually in their migration at that time. They migrated for anything from a few hours to several days between the individually selected staging points (READ & WESTGATE 1997).

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

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 carried out 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 the population size and population development throughout the entire North Sea, which is part of the habitat of these highly mobile animals, without the need for detailed mapping of marine mammals in subareas (seasonal, regional, small-scale). The abundance of harbour porpoises in the North Sea in 1994 was estimated to stand at 341,366 animals on the basis of the SCANS-I survey. A larger area was covered by the SCANS-II survey in 2005, and so a larger number, 385,617 animals, was estimated at that time. However, the abundance calculated over a site of the same size as in 1994 stood at about 335,000 animals. The most recent survey in 2016 showed an average abundance of 345,373 (minimum abundance 246,526, maximum abundance 495,752) animals in the North Sea. The data from SCANS-I and II was recalculated as part of the statistical evaluation of the SCANS-III data. The results from SCANS-I, II and III show no decreasing trend in the abundance of harbour porpoises between 1994, 2005 and 2016 (HAMMOND et al., 2017). However, the regional distribution in 2005 and 2016 differs from the distribution in 1994 in that more animals were counted in the southwest than in the northwest in 2005 (LIFE04NAT/GB/000245, Final Report, 2006), and in 2016 high occurrences were recorded throughout the English Channel. The results of the latest SCANS study (SCANS-III) can be summarised as follows: the calculated abundance of harbour porpoises in the North Sea in 2016 is 345,000 (CV = 0.18) animals and is therefore comparable to the abundance in 2005, with 355,000, and in 1994, with 289,000 (CV = 0.14) animals (HAMMOND et al. 2017).

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

Occurrence of harbour porpoise in the German North Sea

The German EEZ is part of the habitat of the harbour porpoise in the North Sea. The northeastern part of the German EEZ is part of a larger area with high harbour porpoise sighting rates (REID et al. 2003). In comparison, the remaining areas of the German EEZ show lower sighting rates.

The area of the coastal waters and the German EEZ off the North Frisian Islands, especially north of Amrum and near the border with Denmark, is used intensively by harbour porpoises, particularly in the summer months (SIEBERT et al. 2006). Moreover, the presence of calves is always confirmed there during the summer months.

The large-scale studies on the distribution and abundance of harbour porpoises and other marine mammals carried out as part of the MINOS and MINOSplus projects between 2002 and 2006 (SCHEIDAT et al. 2004, GILLES et al. 2006) provide an overview of German waters in the North Sea. The abundance of harbour porpoises in German North Sea waters was estimated at 34,381 animals in 2002 and 39,115 animals in 2003, based on the results from the MINOS studies (SCHEIDAT et al. 2004). Besides pronounced temporal variability, strong spatial variability was also observed. The seasonal evaluation of the data, e.g. in May/June 2006, showed that up to 51,551 animals may have been temporarily present in the German North Sea EEZ (GILLES et al. 2006). The abundance of harbour porpoise at Natura 2000 sites has been monitored since 2008. The abundance varies between from year to year, but it always remains high, especially in the summer months and in spring. The highest abundance recorded in the German North Sea to date was determined in May 2012, with 68,739 animals (see Table 4, taken from GILLES et al. 2012).

Occurrence in conservation areas

Based on the results of the MINOS and EMSON34 studies, three areas of particular importance for harbour porpoises were defined in the German EEZ. In accordance with the Habitats Directive, these were reported to the EU as offshore conservation areas and recognised by the EU as Sites of Community Importance (SCIs) in November 2007: Dogger Bank (DE 1003-301), Borkum Reef Ground (DE 2104-301) and, in particular, Sylt Outer Reef (DE 1209-301). Since 2017, the three FFH areas in the German North Sea EEZ have been assigned conservation area status:

- Ordinance on the establishment of the conservation area "Borkum Reef Ground" (NSGBRgV), Federal Law Gazette I, I p. 3395 of 22 September 2017,
- Ordinance on the establishment of the conservation area "Dogger Bank" (NSGDgbV), Federal Law Gazette I, I p. 3400 of 22 September 2017,
- Ordinance on the establishment of the conservation area "Sylt Outer Reef – Eastern German Bight" (NSGSylV), Federal Law Gazette I, I p. 3423 of 22 September 2017.

The "Sylt Outer Reef – Eastern German Bight" conservation area is the main distribution area for harbour porpoises in the EEZ. Here, the highest densities are often determined in the summer months. The "Sylt Outer Reef – Eastern German Bight" conservation area functions as a nursery area. High numbers of calves are recorded in the "Sylt Outer Reef – Eastern German Bight" conservation area between 1 May and the end of August.

The "Borkum Reef Ground" conservation area is more important to harbour porpoises in spring.

Current results from the monitoring of Natura 2000 sites, as well as from the monitoring of offshore wind farms, confirm a high occurrence of harbour porpoises in conservation areas, especially in the area of the "Sylt Outer Reef" (Gilles et al., 2013).

The BMU has emphasised the importance of the area of the Sylt Outer Reef in the noise protection concept for the harbour porpoise based on these findings, and has defined a main concentration area for harbour porpoise with nursery function (BMU 2013).

Occurrences in areas N-1, N-2 and N-3

Information on the occurrence of marine mammals in areas N-1, N-2 and N-3 for the period 2008 to 2012 is provided by the studies carried out during the third year of study and construction and operation monitoring for the "alpha ventus" project. To this end, extensive surveys of marine mammals were carried out from aircraft and ships in accordance with StUK throughout the entire German EEZ between the traffic separation areas TGB and GBWA, in which the project area is also located. In parallel with the visual surveys, acoustic surveys of harbour porpoises were also carried out using underwater acoustic detectors as part of the studies.

The results from the monitoring of the operating phase of the "alpha ventus" project for the period 2010 to 2012 in accordance with StUK were completed and evaluated with regard to possible impacts from the operation of the installations (ROSE et al. 2014).

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

Additional surveys of marine mammals were carried out between 2009 and 2012 as part of the accompanying ecological research for the "alpha ventus" test site. The study site for surveys from the air covered a large part of the planning area. Ecological research in this respect also focused on recording the impacts of noise-intensive pile driving work and recording possible behavioural reactions of harbour porpoises with regard to operational wind turbines (GILLES et al. 2014). The highest densities were always determined westward of areas N-2 and N-3 in the "Borkum Reef Ground" conservation area. The highest density in 2010 was 2.58 individuals/km2 and was recorded in summer.

Since 2013 onwards, what are known as cluster studies have been performed on a large scale in accordance with the Federal Maritime and Hydrographic Agency standard for the study of the effects of offshore wind turbines on the marine environment (StUK4) in the area north of the East Frisian Islands. The entire area covered by areas N-1, N-2 and N-3 is part of the large study area for the cluster north of Borkum, where nine wind farms have been constructed between 2009 and 2018, and six of which are already in regular operation. This means that current data is available on the occurrence of harbour porpoises and on possible impacts from the construction and operation phases of the wind farms already implemented in the entire area north of Borkum.

Current findings from construction and operation monitoring for the "alpha ventus" test site between 2010 and 2013, from accompanying research for the "alpha ventus" test site and from monitoring Natura 2000 sites, indicate intensive use of the environment by harbour porpoises. The highest densities were always determined westward of the project area in the "Borkum Reef Ground" conservation area. The highest density in 2010 was 2.58 individuals/km^2 and was recorded in summer (GILLES, A., M. DÄHNE, K. RONNENBERG, S. VIQUERAT, S. ADLER, O. MEYER-KLAEDEN, V. PESCHKO & U. SIEBERT, 2014. Supplementary studies on the effect of the construction and operation phase at the "alpha ventus" offshore test site on marine mammals. Final report on accompanying ecological research at the alpha ventus offshore test site for evaluation of the Federal Maritime and Hydrographic Agency standard study concept (StUKplus). Commissioned by the Federal Maritime and Hydrographic Agency; ROSE, A., DIEDERICHS, A., NEHLS, G., BRANDT, M.J., WITTE, S., HÖSCHLE, C., DORSCH, M., LIESENJOHANN, T., SCHUBERT, A., KOSAREV, V., LACZNY, M., HILL, A. & W. PIPER (2014). Offshore Test Site Alpha Ventus; Expert Report: Marine Mammals. Final Report: From baseline to wind farm operation. On behalf of the Federal Maritime and Hydrographic Agency).

The results from all current studies for the "North of Borkum" cluster and from areas N-1, N-2 and N-3 show that harbour porpoises occur in varying numbers throughout the year in this part of the German EEZ. The highest harbour porpoise densities, with values of up to 2.9 individuals/km^2, always occur in spring and the first few months of summer, and are determined based on visual observations. Occasionally, mother-calf pairs also cross the project area in the summer months.

The data from acoustic surveys of harbour porpoises in the extensive study area "north of Borkum" also shows continuous use of the area by harbour porpoises, which is also more intensive in spring and summer.

The results from visual and acoustic surveys also confirm higher harbour porpoise abundance and use of the western part of the study area, in particular the FFH area "Borkum Reef Ground". The abundance and use seem to decrease towards the east.

Harbour seals and grey seals sporadically cross the study area.

Occurrences in areas N-4 and N-13 and a subarea of area N-11

The region of area N-4 is located in the C_South study area of the monitoring operation for the Natura 2000 sites. The findings from the monitoring operation on behalf of the BfN confirm lower densities in the region of area N-4 compared to the C_North area of the monitoring operation in which area N-5 is located. In contrast to the low occurrence of harbour porpoises in the C_South study area, the C_North study area with subarea I of the "Sylt Outer Reef – Eastern German Bight" conservation area shows high seasonal densities in late spring and summer. In summer 2009, for example, an average density of 0.58 individuals/km^2 was found in the immediate vicinity of area N-4; while in subarea I of the "Sylt Outer Reef – Eastern German Bight" conservation area, the average density of 1.64 individuals/km^2 was almost three times as high (e.g. BfN monitoring report – Marine Mammals, 2009-2010). The differences in mean density and abundance were also confirmed during the observations from 2012 onwards.

In May 2012 in particular, the mean density in area N-4 of just 0.50 individuals/km^2 was significantly lower than in the C_North study area or in subarea I of the "Sylt Outer Reef – Eastern German Bight" conservation area, with 2.89 individuals/km2 (BfN monitoring report – Marine Mammals, 2011-2012).

Because of these new findings, areas N-4 and N-13 and a subarea of area N-11 (near the conservation area) are of medium importance for harbour porpoises, or even of high importance in summer, and are part of the identified main concentration area of harbour porpoises in the German North Sea (BMU, 2013).

Area N-4 is located on the western edge of the distribution area for seals and harbour seals from the Schleswig-Holstein Wadden Sea and is therefore of medium importance to both species.

Operational monitoring of the three wind farms "Meerwind Süd/Ost", "NordseeOst" and "Amrumbank West" located in area N-4 has shown that harbour porpoises use this area consistently and continuously, regardless of the construction and operation of the wind farms. While the acoustic surveys using CPODs show a weak positive trend at some long-term stations, the studies using digital surveys show a lower occurrence in the wind farm areas than in areas outside the wind farms (IBL, BioConsult-SH, IfAÖ, 2017).

Occurrence in area N-5

The subareas of area N-5 are used regularly by harbour porpoises for crossing and resting purposes, and they also use them as a feeding ground and nursery area. All studies in the cluster 5 area from research projects such as MINOS, MINOSplus and SCANS surveys, EISs and the monitoring operation for offshore wind farm projects, as well as studies from the monitoring of Natura 2000 sites, always confirm high numbers of calves in the summer months. The waters west of Sylt are thought to be used by harbour porpoises as a nursery area due to the high numbers of calves sighted. Area N-5 is thus part of a large area used as a feeding ground and nursery area by 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 region of the subareas of area N-5. Area N-5 is located in the C_North area of the study design for the Natura 2000 sites. In 2008, an average density of 2.28 individuals/km² was determined for the C_North area (BfN monitoring report – Marine Mammals, 2008-2009). In summer 2009, the density in the C_North area was just 1.64 individuals/km^2 (BfN monitoring report – Marine Mammals, 2009-2010). In June 2010, a density of 2.12 individuals/km^2 was again recorded (BfN monitoring report – Marine Mammals, 2010-2011).

These values were also confirmed by the monitoring operation in the years that followed. The abundance for the C_North study area amounted to 23,163 animals in May 2012. This corresponds to an average density of 2.89 individuals/km², significantly higher than in the adjacent C_South study area to the south (BfN monitoring report – Marine Mammals, 2011-2012, 2014-2015).

The most comprehensive information currently available is provided by the data collected as part of the monitoring operation for the "DanTysk" and "Butendiek" wind farm projects: over the entire period covered, harbour porpoises were sighted in the "DanTysk" study area, the western part of area N-5. In 2011, for example, a total of 1,702 animals were recorded. The highest occurrence was observed mainly in summer. The mean density in the summer months was 3.8 individuals/km², and calf numbers varied between 10 and 25%. The highest numbers of calves were recorded in June, July and August (BIOCONSULT SH 2012a).

In the "Butendiek" study area immediately to the east, where the eastern part of area N-5 is located, it was found that harbour porpoise numbers remained low between September and March and did not increase until the end of April. High densities, on the other hand, were observed in the summer months. The highest density, with 5.9 individuals/km², was determined in June. The calculated mean density in summer was 2.2 individuals/km² and was thus within the range of the densities determined during the BfN monitoring operation (BIOCONSULT SH 2012b). The high variability of the occurrence between the individual study days in summer was striking, given the high-frequency studies presented here for the two study areas for the "DanTysk" and "Butendiek" projects.

The data from the ongoing operational monitoring of the "Butendiek" wind farm fits well into the long-term data series from this area and shows that interannual fluctuations in the abundance of harbour porpoises have occurred throughout the entire study area over the last three to five years, including during the construction of the "Butendiek" wind farm. However, no clear trend is discernible as a slight decrease in harbour porpoise numbers was observed between the first years of the baseline survey (2001-2003) and the third year of the baseline survey (2011). This observation is supported by data from the literature and points to longer-term summer migration of harbour porpoises from coastal areas of the eastern North Sea towards the west between 2003 and 2013. However, as this decrease began well before construction commenced, construction and operation of the wind farm is in no way linked with this. Continuous data from the acoustic monitoring operation using C-PODs indicates the highest detection rates in late spring and early summer; in contrast to the other study methods, acoustic monitoring at some stations also showed high detection rates in autumn. Trend analyses of the duration of C-POD stations in area 5 confirm the results from surveys performed by aircraft and ships in recent years and show a slightly positive trend over the last five years. Overall, the data from all survey methods shows that harbour porpoises are constantly present throughout the entire area 5, and that their occurrence follows a relatively stable phenological pattern over years. On a small scale, however, the occurrence fluctuates quite strongly in both spatial and temporal terms. Due to these fluctuations, the increase in migration into the area from April/May and the appearance of calves with simultaneous high summer density, this part of the EEZ can continue to be regarded as an important feeding and reproduction area (BIOCONSULT SH 2018).

Occurrences in areas N-6, N-7, N-8, N-9, N-10, N-11 (subarea) and N-12

Current information on the occurrence of harbour porpoises in the subarea of the German

EEZ of areas N-6 to N-10, N-12 and, in part, N-11 is provided by operational monitoring for the "BARD Offshore I", "Veja Mate" and "Deutsche Bucht" projects, as well as "EnBW HoheSee" and "Albatros". Higher densities occur mainly in spring and late summer, while lower densities occur in autumn and early winter in particular. In terms of the annual mean, the absolute frequencies in study years 2008 to 2013, with values between 0.34 individuals/km² and 0.98 individuals/km², are slightly to clearly above the values determined for years 2004 to 2006. Over the course of the year, a mean density of 0.5 harbour porpoises/km² can be expected in this part of the German EEZ, daily values generally varying between 0 and 2 individuals/km² depending on the season. The results of the acoustic monitoring operation performed since 2008 and to date confirm the occurrence. Moreover, the results from acoustic monitoring indicate that harbour porpoise activity is also high in the winter months. The number of calves recorded in 2008-2013 still does not indicate particular importance of the area for the reproduction of the species. While a relatively stable abundance of harbour porpoises was recorded between 2005 and 2012, the figure decreased in the years that followed. It was not until the end of 2016 that a steady increase in the occurrence of harbour porpoises began to emerge again in the central part of the German EEZ in the North Sea (final report on the construction phase of the OWP "BARD Offshore 1", PGU 2014, cluster monitoring cluster 6, report phase I (01/15 – 03/16) for the OWPs "BARD Offshore I", "Veja Mate" and "Deutsche Bucht", PGU 2017, environmental monitoring in the cluster "East of Austerngrund", annual report 2016 – April 2015 – March 2016).

2.8.2.2 Seals and grey seals

The harbour seal is the most common seal species in the North Atlantic and can be found along coastal regions throughout the North Sea. Regular aerial surveys are carried out throughout the Wadden Sea at the peak of the moulting season in August. In 2005, 14,275 harbour seals were counted in the entire Wadden Sea (ABT et al. 2005). As some of the animals are always in the water and therefore not counted, this figure reflects the minimum population.

Suitable undisturbed resting grounds are of crucial importance for the occurrence of harbour seals. In the German North Sea, sandbanks are mainly used as resting places (Schwarz & Heidemann, 1994). Telemetric surveys show that adult harbour seals in particular rarely move more than 50 km away from their traditional resting grounds (TOLLIT et al. 1998). When searching for food, they normally travel about 50 to 70 km away from their resting places to the hunting grounds (z. B. THOMPSON & MILLER 1990), although they may travel up to 100 km in the Wadden Sea region (ORTHMANN 2000).

Grey seal counts during the moulting season in the German North Sea have only been performed occasionally to date. In 2005, 303 animals were counted in the moulting season in Schleswig-Holstein. A hundred animals were estimated for Lower Saxony (AK SEEHUNDE 2005). These figures merely provide a measurement at a single point in time.

Strong seasonal fluctuations are reported (ABT et al. 2002, ABT 2004). The figures observed in German waters must be viewed in an extended geographical context, as grey seals sometimes undertake very long migrations between different resting places throughout the North Sea area (MCCONNELL et al. 1999). The feeding grounds for grey seals observed at the resting places in coastal waters are probably partly in the EEZ.

2.8.3 Status assessment of the factor Marine mammals

The number of harbour porpoises in the North Sea has declined over the last few centuries. The situation for harbour porpoises has generally deteriorated in the past. In the North Sea, populations have declined mainly due to bycatch, pollution, noise, overfishing and limitations on food (ASCOBANS 2005). However, there is a lack of specific data available that will allow a trend to be calculated or trend development to be forecast. The best overview of the distribution of harbour porpoises in the North Sea can be found in the summary in "Atlas of the Cetacean Distribution in North-West European Waters" (REID et al. 2003). However, when calculating abundance or populations based on flights or even excursions, the authors point out that the occasional sighting of a large group of animals within an area, recorded over a short time, can lead to an assumption of unrealistically high relative densities (REID et al. 2003). Identification of distribution patterns or calculation of populations is made particularly difficult due to the high mobility levels of animals.

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

Statistical evaluation of data from the large-scale surveys in the context of research projects and, since 2008, in the context of the monitoring of Natura 2000 sites on behalf of the BfN indicates a clearly significant increase in harbour porpoise densities in the southern German North Sea between 2002 and 2012. In the area of the Sylt Outer Reef, the trend analysis also indicates stable populations in the summer between 2002 and 2012 (GILLES et al. 2013). The western region in particular shows a positive trend for spring and summer, while there is no clear trend in autumn. The density of harbour porpoises in the eastern region has remained largely constant over the years, and significant differences have been observed between the hotspots in the west and lower density in the southeastern German Bight.

Current findings from large-scale cluster studies of offshore wind farms do not indicate a decreasing trend in the abundance of harbour porpoises, or any change in seasonal distribution patterns in the German North Sea EEZ between 2001 and the present day. Several years of data from the CPOD station network confirm continuous use of habitats by harbour porpoises.

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

2.8.3.1 Importance of areas and sites for marine mammals

According to the latest information available, it can be assumed that the German EEZ is used by harbour porpoises for crossing and resting, and also as a feeding ground and – in specific locations – as a nursery area. Given the available information, medium to high regional importance of the EEZ for harbour porpoises can be inferred. The use of habitats varies in different parts of the EEZ. Marine mammals and, of course, harbour porpoises are highly mobile species which use large areas to search for food depending on hydrographic conditions and the food supply available. It therefore makes little sense to consider the importance of individual sites, such as the sites in the plan or individual wind farm sites. The importance of areas that belong to a natural unit and that were additionally covered by intensive, project-related studies is assessed separately below.

Areas N-1, N-2 and N-3

According to the latest information available, areas N-1 to N-3 are of medium to high importance for harbour porpoises on a seasonal level, in spring. The studies carried out as part of the monitoring operations for Natura 2000 sites and the offshore wind farm projects always confirm a significantly higher occurrence in the "Borkum Reef Ground" conservation area, with decreasing densities heading eastwards.

- The areas are used by harbour porpoises all year round for crossing, resting and, probably, as a feeding ground.
- Harbour porpoises use the areas significantly more extensively in spring.
- Harbour porpoises use the areas to a fairly average degree in summer, compared to their use of the waters west of Sylt.
- The sightings of calves in the areas are rather sporadic and irregular, so it is highly unlikely that this region is used as a nursery area.
- There is no evidence to indicate a continuous specific function for areas N-1, N-2 and N-3 for harbour porpoises.

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

Areas N-4 and N-13 and subsection of area N-11

According to the information currently available, areas N-4 and N-13 and the eastern subarea of area N-11 (near the conservation area) are of medium importance for harbour porpoises, or even of high importance in summer, 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, resting and, probably, as a feeding ground.
- The presence of harbour porpoises in the vicinity of areas N-4, N-13 and N-11 is relatively high, but lower compared with the high numbers found in the waters west of Sylt (area N-5).
- Regular sightings of calves in these areas, albeit in comparatively small numbers, permit the assumption that these areas are to be viewed as peripheral parts of the large nursery area in the German North Sea EEZ.
- Due to their function as a feeding ground and, occasionally, as a nursery area, areas N-4, N-13 and parts of area N-11 are of medium to seasonal high importance for harbour porpoises.

Area N-4 is located on the western edge of the distribution area for seals and harbour seals from the Schleswig-Holstein Wadden Sea and is therefore of medium importance to both species.

Areas N-11 and N-13 are of very little importance for seals and harbour seals.

Area N-5

The sites of area N-5 are used regularly by harbour porpoises for crossing and resting purposes, and they also use them as a feeding ground and nursery area.

According to the latest information available, the environment in which the sites of area N-5 are located is of great importance to harbour porpoises and represents the core area of the identified main concentration area of harbour porpoises in the German North Sea (BMU 2013):

- The regions are used by harbour porpoises all year round for crossing, resting and as a feeding ground.
- Harbour porpoises use the sites of area N-5 to a particularly intensive extent in summer.
- All sites in area N-5 are used by harbour porpoises as a nursery area during the summer months.
- The density of harbour porpoises in this area is high compared with other parts of the EEZ.
- The sites of area N-5 are of great importance to harbour porpoises, in particular as a feeding ground and nursery area.

Area N-5 is located on the western edge of the distribution area for seals and harbour seals from the Schleswig-Holstein Wadden Sea and is therefore of medium importance to both species.

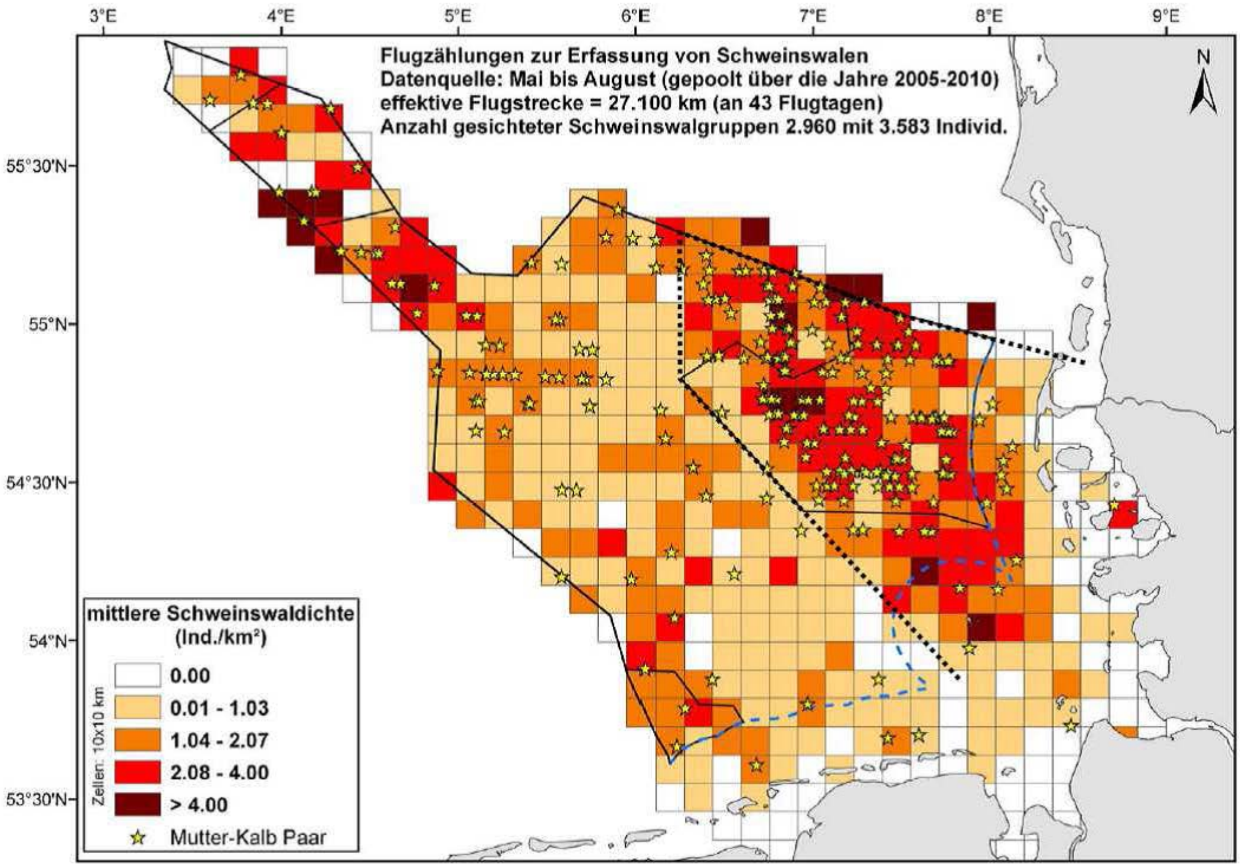


Figure 28: Grid view of the distribution of harbour porpoises in the German North Sea and sightings of mother-calf pairs (GILLES, unpublished, cited in BMU, 2013).

Areas N-6, N-7, N-8, N-9, N-10, N-11 (subarea) and N-12

Areas N-6, N-7, N-8, N-9, N-10, N-11 (western subarea) and N-12 are used regularly by harbour porpoises for crossing and resting purposes, or as a feeding ground (depending on the food available in any one season).

Their use as a nursery area can almost certainly be ruled out as there have been few sightings of mother-calf pairs. Given the latest information available, these areas can be considered to be of medium importance for harbour porpoises:

- The areas are used by harbour porpoises all year round for crossing, resting and, probably, as a feeding ground.
- Harbour porpoises use the areas significantly more extensively in spring and summer.
- The occurrence of harbour porpoises in these areas is average compared with the high numbers found in the waters west of Sylt.
- The irregular sighting of individual mother-calf pairs makes it highly unlikely that these areas are used as a nursery area.
- There is no evidence to indicate a continuous specific function for the areas for harbour porpoises.

These areas are of no special importance to the two seal species due to the distance to the nearest resting and breeding grounds.

2.8.3.2 Protection status

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

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

There is also the Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention), and the harbour porpoise is listed in Annex II to this. In Germany, the harbour porpoise is also included in the Red List of Threatened Animals (Binot et al., 1998). They are classified as belonging to threat category 2 (critically endangered).

The grey seal and harbour seal are also listed in Annex II of the Habitats Directive. The grey seal is also classified as belonging to threat category 2 in the Red List. The harbour seal is classified as belonging to conservation category 3 (endangered).

2.8.3.3 Hazards

The harbour porpoise population in the North Sea is threatened by a variety of anthropogenic activities, changes to the marine ecosystem, diseases and climate change.

Prior impacts on marine mammals result from fishing, underwater noise immissions and pollution. Fishing presents the greatest threat to porpoise populations in the North Sea due to bycatch and the depletion of prey fish populations through overfishing.

Current anthropogenic applications in the EEZ resulting in high noise pollution include seismic surveys, sand and gravel extraction and military uses, as well as shipping. Marine mammals may be endangered during the construction of wind farms and converter platforms with deep foundations, in particular due to noise emissions during the installation of foundations if no measures are taken to reduce or prevent noise.

Besides pollution caused by the discharge of organic and inorganic contaminants or oil spills, the population is also at risk from diseases (of bacterial or viral origin) and climate change (impact on the marine food chain in particular).

2.9 Seabirds and resting birds

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

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

2.9.1 Data availability

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

The findings on the spatial and temporal variability of the occurrence of seabirds in the southern North Sea are based on observations by ESAS (European Seabirds at Sea), as well as on a number of research projects (e.g. MINOS, MINOSplus, EMSON, StUKplus, HELBIRD, DIVER, TOPMarine) restricted both temporally and spatially. In recent years, the data basis has expanded considerably due to a large number of new study programmes for the monitoring of Natura 2000 sites, environmental impact studies, monitoring of offshore wind farms during construction and operation, and research projects focusing on scientific assessments of existing data in the German North Sea EEZ. The available data basis can therefore be regarded as very good.

2.9.2 Spatial distribution and temporal variability

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

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

A number of studies have shown that some areas of German coastal waters and parts of the North Sea EEZ are of great importance to seabirds and water birds not only nationally, but internationally as well, and were identified very early on as being areas of special importance to seabirds, known as "Important Bird Areas – IBAs" (SKOV et al. 1995, HEATH & EVANS 2000). Subarea II of the "Sylt Outer Reef – Eastern German Bight" conservation area established by ordinance of 22 September 2017 should be mentioned in particular here, as this was already designated a Special Protected Area (SPA) in accordance with the Birds Directive (79/409/EEC) by ordinance of 15 September 2005.

With regard to the species group of divers, a main concentration area in the German Bight was identified in spring as part of a comprehensive evaluation and assessment initiative for existing datasets (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 found in larger populations as resting birds. The following Table 8 includes population estimates for the most important seabird species in the EEZ, and shows the entire German North Sea during the strongest seasons in terms of occurrences.

Table 8: Populations of the most important resting bird species in the German North Sea and the EEZ in the strongest seasons in terms of occurrences, 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).

English name (*scientific name*)	Season	Population German North Sea	Population German Exclusive economic zone
Red-throated diver (*Gavia stellata*)	Winter	3,600	1,900
	Spring	22,000	16,500
Black-throated diver (*Gavia arctica*)	Winter	300	170
	Spring	1,600	1,200
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	Summer	76,000	29,000

(*Larus fuscus*)	Autumn	33,000	14,500
Common gull (*Larus canus*)	Winter	50,000	10,000
Little gull (*Hydrocoloeus minutus*)	Winter	1,100	450
Black-legged kittiwake (*Rissa tridactyla)*	Winter	14,000	11,000
	Summer	20,000	8,500
Sandwich tern (*Thalasseus sandvicensis*)	Summer	21,000	130
	Autumn	3,500	110
Common tern (*Sterna hirundo*)	Summer	19,500	0
	Autumn	5,800	800
Arctic tern (*Sterna paradisaea*)	Summer	15,500	210
	Autumn	3,100	1,700
Razorbill (*Alca torda*)	Winter	7,500	4,500
	Spring	850	800
Guillemot (*Uria aalge*)	Winter	33,000	27,000
	Spring	18,500	15,500

2.9.2.2 Frequently occurring species and species of special importance for the nature conservation area "Sylt Outer Reef – Eastern German Bight"

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

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

It is not always possible to tell the two species apart reliably in ship-based and airborne surveys. This is why the two species are presented together in this instance. According to all previous information, the percentage of black-throated divers thus stands at around 8 to 11%.

In winter, divers are regularly found along the coast of the southeastern North Sea. The focal point of the occurrence shifts further north as spring approaches, especially to the west of Sylt (see Figure 29). At this time of year, the distribution reaches almost 100 km into the EEZ (MENDEL et al. 2008). With many years of data collection in the German EEZ, a main distribution area (main concentration area) of divers was identified and defined off the North Frisian Islands in spring (BMU 2009). Evaluation of data from research projects, environmental impact studies and monitoring of offshore wind farm projects from 2000 to 2013 prior to construction of the wind farms showed that the seasonal concentrations of divers in the German Bight had remained largely constant over a fairly long time. Clear expansion of the occurrence of divers in a westerly direction was observed at the same time, which confirmed the importance of the main concentration area (GARTHE et al. 2015). A current study by FTZ on behalf of Federal Maritime and Hydrographic Agency and BfN, which takes into account data from the construction and operation phase of the offshore wind farm projects in 2014-2017, in addition to the data basis of the study from 2015, shows displacement of the occurrence of divers to the central region of the main concentration area after construction of the wind farms (GARTHE et al. 2018).

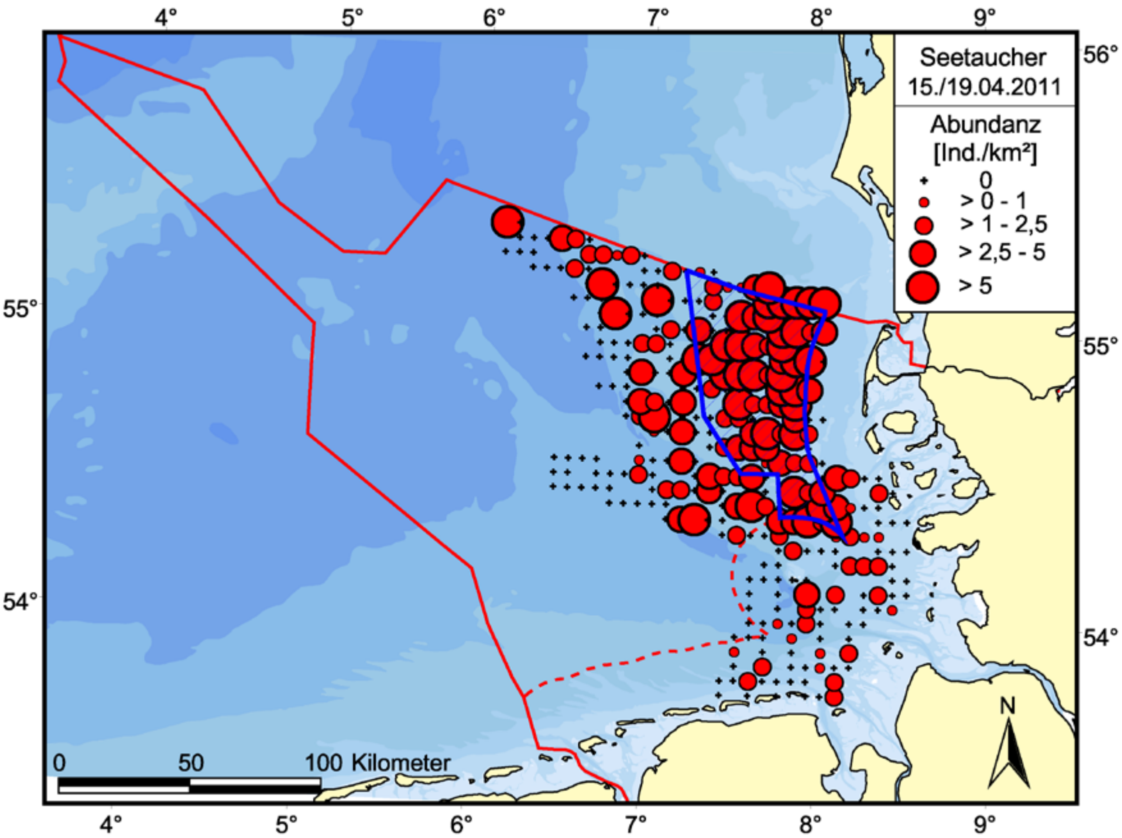


Figure 29: Occurrence of divers in the German Bight – aerial survey performed on 14 and / 15 April 2011 (MARKONES & GARTHE 2011, 2010/2011 monitoring report on behalf of BfN).

Little gull (*Larus minutus*)

The German Bight, where little gulls achieve only low population densities, is located on the northeastern edge of the winter distribution of European little gulls (GLUTZ von BLOTZHEIM & BAUER 1982). In general, a considerable portion of the northwestern European population flies over the coastal areas of the German North Sea coast during autumnal and vernal migration, as long-term observations from research projects and EISs show consistently. High densities can then be found, particularly in the area around the mouth of the Elbe (MARKONES et al. 2015). Only isolated individuals remain in the German EEZ during the breeding season and in the summer (MENDEL et al. 2008). The high number of occurrences during autumnal migration is followed by a smaller, constant winter occurrence in the German North Sea, restricted mainly to coastal waters, the "Sylt Outer Reef – Eastern German Bight" conservation area and the "Borkum Reef Ground" conservation area. Generally, the occurrence is strongly dependent on the prevailing weather conditions.

Sandwich tern (*Sterna sandvicensis*)

The distribution area of the sandwich tern in the pre-breeding season, during the breeding season and during the autumnal migration along the North Sea coast, with most birds in a "strip" 20 to 30 km wide and concentrations near known breeding colonies on the islands of Norderoog, Trischen and Wangerooge.

The FTZ's long-term data series shows the main occurrence of sandwich terns in the German North Sea during the summer. At this time, sandwich terns occur extensively in the coastal waters as a whole. Sandwich terns occur only sporadically in the area outside the coastal waters (MENDEL et al. 2008). Hardly any sandwich terns search for food in areas where the water is more than 20 m deep.

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

It is not always possible to reliably tell common terns and Arctic terns apart under unfavourable observation conditions, so these are presented together. Both common terns and Arctic terns remain in an offshore "strip" during the breeding season that only projects slightly into the northern part of the EEZ itself. The highest densities are found near the breeding grounds on the offshore islands. The distribution of the two tern species after the breeding season is very much reminiscent of the situation during the breeding season. However, local concentrations are less clear in the vicinity of the breeding grounds, which are no longer occupied at this time. The EEZ takes on rather more importance after the breeding season, particularly the area off the North Frisian Islands (MENDEL et al. 2008).

Common gull (*Larus canus*)

Common gulls are widespread in the eastern and southern coastal areas of the German Bight in winter. The highest densities are achieved in the Elbe-Weser estuary, in the region of the Ems estuary and off the North Frisian Islands. The long-term FTZ data series shows that common gulls remain in the German North Sea all year round, but that the largest offshore populations occur in winter. The winter occurrence extends, with high densities, over the entire coastal area up to the 20 m isobath. Common gulls still occur regularly in offshore areas, albeit in clearly smaller numbers (MENDEL et al. 2008). Common gulls remain nearer to coasts in the other seasons, and their breeding grounds are also located here (see Figure 30). The occurrence of common gulls is also very much dependent on the weather.

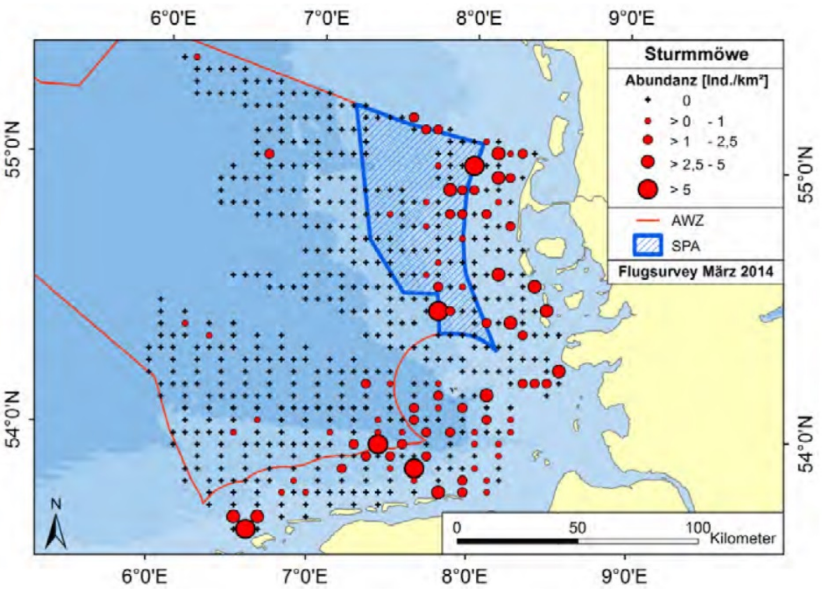


Figure 30: Occurrence of common gulls in the German North Sea – survey from 4, 12 & 13 March 2014 (MARKONES et al., 2015, 2014 monitoring report on behalf of BfN).

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

The guillemot is a typical seabird that only spends time on land during the breeding season. The only breeding colony in German waters is on Helgoland and is estimated to comprise around 2,600 breeding pairs (BIRDLIFE INTERNATIONAL 2004a). In the breeding season, the birds leave the colony only to search for food over a radius of up to no more than 30 km. During the breeding season, therefore, the occurrence of guillemots is concentrated to the German Bight and the spatial environment of the breeding colony on Helgoland. Further to the northwest, the occurrence of guillemots is low at this time of year (MENDEL et al. 2008).

In autumn, the occurrence of guillemots shifts to offshore areas with water depths of between 40 and 50 m up to what is known as the "Entenschnabel" of the German EEZ (MARKONES & GARTHE 2011) (see Figure 31). Adult birds are frequently observed with their young at this time, although these most probably come from British breeding colonies.

In winter, the highest densities of guillemots are achieved and they occur almost everywhere in the German North Sea EEZ (MENDEL et al. 2008). According to the latest information available, the regions of the EEZ between and north of the traffic separation areas off the East Frisian coast are used intensively by guillemots in autumn and winter. In the spring, guillemots retreat gradually toward their breeding colony.

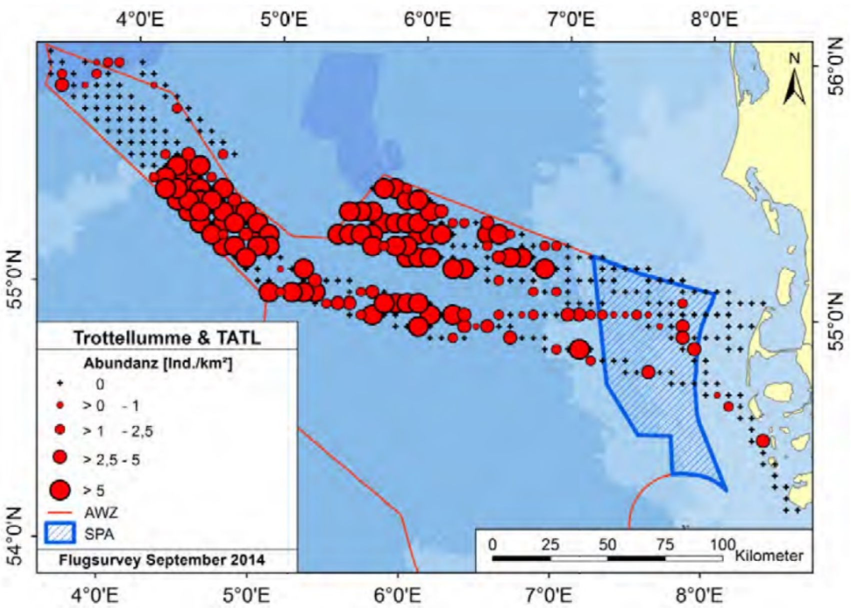


Figure 31: Occurrence of guillemots and uncertain individuals of the guillemot/razorbill species group in the German North Sea – aerial survey performed on 1 and 29 September 2014 (MARKONES et al., 2015, 2014 monitoring report on behalf of BfN). The proportion of razorbills in the uncertain species group is very likely to be low at this time of year (see explanations on the distribution of razorbills).

<u>Razorbill (*Alca torda*)</u>

Razorbills are distributed relatively evenly over the coastal waters of the EEZ in winter. There is a clear concentration off the East Frisian Islands. The occurrence in German waters remains low at other times of the year (MENDEL et al. 2008).

The FTZ's long-term data series shows the main occurrence of razorbills during the winter months. The highest concentrations occur north of Borkum and Norderney and extend into the offshore area (MENDEL et al. 2008).

Gannet (*Sula bassana*)

Low gannet densities are found in large parts of the German North Sea, no particular concentrations being detected. This is confirmed by more recent studies (MARKONES et al. 2014, MARKONES et al. 2015). Despite the currently observed increase, the Helgoland breeding colony is too small in numbers to be clearly noticeable at sea. The FTZ's long-term data series shows a year-round but low occurrence of gannets throughout the entire German Bight (MENDEL et al. 2008).

Northern fulmar (*Fulmarus glacialis*)

Northern fulmars occur almost everywhere in the German North Sea, all year round. They occur in higher density in offshore areas than in coastal areas (MARKONES et al. 2015). The FTZ's long-term data series shows a year-round occurrence in the German Bight. However, the highest numbers are found in summer, in areas where the North Sea water is salty and thermally stratified (MENDEL et al. 2008). The baseline surveys for offshore wind farm projects also revealed that Northern fulmars occur at higher densities beyond the 40 m isobath. The breeding colony on Helgoland is still too small to significantly influence the populations at sea. Northern fulmars occur regularly and in high density at a distance of more than 70 km from the coast, especially in summer.

Great black-backed gull (*Larus marinus*)

Great black-backed gulls are present in the German North Sea all year round. They occur at low densities in spring and summer both near the coast and offshore, 80 km from the coast. In autumn, the occurrence increases steadily and culminates in a high number of winter occurrences in the Elbe estuary region and along the East Frisian coast. Only occasional great black-backed gulls can be found in the offshore area (MENDEL et al. 2008). A current trend analysis based on comprehensive ship transect studies from the period 1990 to 2013 showed a significantly negative development in great black-backed gull populations in the North Sea. However, this is not due to a decrease in the breeding population, but an increasing shift in resting populations and the decreasing importance of marine food sources (MARKONES et al. 2015).

Lesser black-backed gull (*Larus fuscus*)

The main distribution of lesser black-backed gulls is approximately 60 km off the coast during the vernal migration period and in the pre-breeding season. The lesser black-backed gull is a widespread species in the German Bight both during and after the breeding season, and concentrations occur in coastal waters off Schleswig-Holstein and Lower Saxony and the adjacent areas of the EEZ, particularly west of the island of Helgoland. The lesser black-backed gull is famous for following ships. This is why their sometimes highly concentrated occurrence can often be observed in connection with fishing activity. The lesser black-backed gull is the only seabird species to occur in high densities during the summer months in the area around the island of Helgoland, and it is the most common seabird species in the German North Sea during this period. As with the great black-backed gull, recent studies show a decrease in the summer population of the lesser black-backed gull in the German North Sea. However, this is due not to a decline in the breeding population, but to relocation of the population to terrestrial areas (MARKONES et al. 2015).

Black-legged kittiwake (*Rissa tridactyla*)

The black-legged kittiwake is one of the bird species observed most frequently in the German North Sea EEZ, after the lesser black-backed gull and the guillemot, and it occurs all year round. The FTZ's long-term data series shows a clearly concentrated population around Helgoland in spring and summer, and in a northwesterly direction along the Elbe-Urstromtal Valley in summer.

In autumn, the population also expands into offshore areas. The population increases in coastal areas in winter, but local accumulations with a large number of individuals also occur in scattered locations in offshore areas (MENDEL et al. 2008). This is also shown by more recent studies within the framework of seabird monitoring on behalf of the BfN (MARKONES et al. 2014).

Great skua (*Stercorarius skua*)

Great skuas are rarely seen in the German Bight. Occasional occurrences are possible all year round, but a concentration can be seen in particular during the autumnal migration from the end of June to November. In the eastern part of the German Bight, the occurrence is often observed in connection with strong westerly winds (DIERSCHKE et al. 2011).

Pomarine skua (*Stercorarius pomarinus*)

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

Common scoter (*Melanitta nigra*)

Common scoters spend the whole year in the German North Sea, but their populations are concentrated at coastal areas and flatter offshore areas. The occurrence of common scoters is determined by migratory movements in spring and autumn. The coastal areas serve as important resting habitats in winter, while a moult migration can be observed in summer. Compared to the German North Sea as a whole, the "Eastern German Bight" offshore bird reserve has only very small populations in summer and autumn (MENDEL et al. 2008).

2.9.2.3 Occurrence of seabirds and resting birds in the areas

The areas defined in the Site Development Plan for offshore wind farms in the North Sea can be described in more detail with regard to the occurrence of seabirds, as extensive data is available from environmental impact studies and the monitoring of offshore wind farms during construction and operation. This data is based on surveys from ships and the air.

Areas N-1, N-2, N-3

The extensive surveys of seabirds within the framework of environmental impact studies and during the construction and operating phases of offshore wind farms show that a seabird community is to be found in areas N-1, N-2 and N-3, as is to be expected for the prevailing water depths and hydrographic conditions, the distance from the coast and local influences (IFAÖ et al. 2015a, IFAÖ et al. 2015b). The seabird population is dominated by seagulls, especially those that are known to be ship followers and benefit from fishing waste (e.g. lesser black-backed gulls). Little gulls occur only sporadically, while common gulls occur in autumn and winter regardless of fishing activities. Deep-sea bird species such as guillemots and razorbills are some of the most frequent types, alongside black-legged kittiwakes and lesser black-backed gulls. That said, bird species living near to the coast, such as terns and ducks, are found only in small numbers and are only seen flying during the main migration periods. The area is of no special significance as a feeding ground for diving sea ducks due to the depth of the water (BIOCONSULT SH & CO.KG & IFAÖ 2014, IFAÖ et al. 2015a, IFAÖ et al. 2015b). Divers use this coastal area of the EEZ in winter and spring for the most part. Studies show a concentrated distribution of divers within the 12 nautical mile zone off the East Frisian Islands. Occasionally, however, they also occur within and in the vicinity of areas N-1 to N-3 (GARTHE et al. 2015, IFAÖ et al. 2016, IFAÖ et al. 2017). Current analyses show a larger occurrence southeast of area N-3 (GARTHE et al. 2018).

All in all, close examination of all available data suggests differing uses of the three subareas, specific to individual species. The presence of concentrations is not discernible. Species-specific density gradients (e.g. coastal versus offshore) and seasonal distribution patterns can be identified. All previous studies also clearly indicate the strong interannual variability of bird occurrence in this area. Compared to other areas of the German North Sea, the sea area between the two traffic separation areas has a medium seabird occurrence. Bird species listed in Annex I of the Birds Directive occur only briefly, and with low densities.

Area N-4

The data from the region in the vicinity of area N-4 shows a medium seabird occurrence that is occasionally high. The entire region of the eastern German Bight, in which area N-4 is also located, is of high importance to a total of six species (groups): the red-throated diver, the black-headed diver, the little gull, the common gull, the common scoter and terns (common terns, Arctic terns and sandwich terns).

However, the common scoter can be observed only rarely, or not at all, in the region of area N-4 due to the depth of the water, which exceeds 20 m. In recent studies, dense populations of common scoters have only been observed at the extreme northeast margin of area N-4 (IBL UMWELTPLANUNG et al. 2016b, IBL UMWELTPLANUNG GMBH et al. 2017a, IBL UMWELTPLANUNG GMBH et al. 2018). Common gulls occur in and around area N-4 in the autumn and winter for the most part, mostly over a wide area. Little gulls can occur all year round in area N-4, but they are most common in spring and winter. Terns occur mainly during the migration periods. In recent studies, the occurrence was concentrated in the north of area N-4 (IBL UMWELTPLANUNG GMBH et al. 2017a, IBL UMWELTPLANUNG GMBH et al. 2018). Area N-4 is located in the southern part of the main concentration area for divers in spring (BMU 2009). In species-specific spring, from March to May, higher densities of divers are regularly observed in the vicinity of the area, especially northwest and east of N-4 (IBL UMWELTPLANUNG GMBH et al. 2017a, IBL UMWELTPLANUNG GMBH et al. 2018).

The most commonly occurring species are lesser black-backed gulls, black-legged kittiwakes (especially in association with fishing activities), common gulls (regardless of fishing activities, in high densities especially in autumn and winter) and auks. The latter, mainly guillemots and razorbills, occur in only unexceptional numbers in the vicinity of area N-4 compared to the offshore areas of the EEZ. The region in the immediate vicinity of area N-4 is used as a feeding ground to an extent in the summer by breeding birds from the breeding colonies of Helgoland. Northern fulmars and gannets occur rather sporadically. The area is of no special importance to diving sea ducks. Other bird species in Annex I of the Birds Directive only occur in unexceptional numbers.

Area N-5

The region in the vicinity of area N-5 has a large population of seabirds. All previous results show a gradient in the composition of the bird community: the region east of area N-5 marks the transition between coastal areas with water depths below 20 m and areas further from the coast, with increasing water depth. The region in the vicinity of area N-5 thus shows a mixed bird community, with a high proportion of coastal birds in coastal areas, which merges into a deep-sea bird community to the west as the water depth increases (BIOCONSULT SH & Co. KG 2015). In recent studies, the common scoter was the most common species in both ship-based and digital airborne surveys in the study area east of area N-5 (BIOCONSULT SH & Co. KG 2017, BIOCONSULT SH & Co. KG 2018). In area

N-5, deep-sea species such as black-legged kittiwakes, *Larus* gulls and auks dominate increasingly. There are also Northern fulmars west of area N-5 in late winter and summer (IFAÖ 2016a, IFAÖ 2017). Gannets only occur in small numbers in the vicinity of N-5 during migration periods (BIOCONSULT SH & Co. KG 2018, IFAÖ 2017).

Species listed in Annex I of the Wild Birds Directive occur regularly. All subareas of area N-5 are located in the main concentration area for divers in the German Bight in spring (BMU 2009). High densities with pronounced intraannual and interannual variability are observed in the region around area N-5 from March to mid-May (species-specific spring) (GARTHE et al. 2015). According to recent studies, the occurrence of divers is concentrated east of area N-5 within the southern and northern extension of the bird reserve, as well as south of area N-5. Only occasional divers can be observed at other times of the year (BIOCONSULT SH & Co. KG 2017, BIOCONSULT SH & Co. KG 2018, IFAÖ 2017, IFAÖ 2018). In the region of area N-5, low densities of little gulls occur mainly during the migratory periods and in winter. These densities increase from west to east. Terns were occasionally observed east of area N-5 during migratory periods and in summer (BIOCONSULT SH & Co. KG 2018, IFAÖ 2017).

Areas N-6 to N-13

Areas N-6 to N-13 north of the traffic separation areas are characterised by medium to seasonal short-term high occurrences of seabirds. The species composition and, above all, the abundance conditions indicate that these areas are a typical habitat for the deep-sea bird community. Guillemot, black-legged kittiwake, razorbill and lesser black-backed gull are the most common species. Seagulls are observed here, mainly hunting for fishing waste. However, common gulls occur in small numbers in autumn and winter, regardless of fishing activities. Northern fulmars and gannets are observed all year round in this part of the EEZ. However, there are strong intraannual and interannual fluctuations in these occurrences (PLANUNGSGEMEINSCHAFT UMWELTPLANUNG OFFSHORE WINDPARK 2015, IBL UMWELTPLANUNG et al. 2016a, IBL UMWELTPLANUNG et al. 2017b).

Species listed in Annex I of the Birds Directive may occur sporadically in areas N-6 to N-13 during migration periods and in winter. There are no identifiable concentrations in occurrences of little gulls, terns and divers. This part of the EEZ is used by them as a transit area (IBL UMWELTPLANUNG et al. 2017b). In comparison to the distribution area for divers, only low diver densities were observed in the adjacent areas in spring (IFAÖ 2016b).

The depth of the water means that the eight areas are of no importance as resting and feeding habitats for diving sea ducks that hunt for food on the seabed. Many of the exclusively fish-eating deep-sea bird species found here hunt for food by diving in the water column. These species are attracted by the concentrated occurrence of fish and macrozooplankton.

The nature of these eight areas means that they are part of the large-scale habitat of the guillemot in the North Sea. The surveys carried out within the framework of environmental impact studies and monitoring have indicated the presence of young guillemots in this part of the EEZ during the post-breeding period (MARKONES & GARTHE 2011, MARKONES et al. 2014, PLANUNGSGEMEINSCHAFT UMWELTPLANUNG OFFSHORE WINDPARK 2015). However, guillemots are not bound to specific habitats outside the breeding period (CAMPHUYSEN 2002, DAVOREN et al. 2002, VLIESTRA 2005, CRESPIN et al., 2006, FREDERIKSEN et al. 2006). This is supported by:

- the potential for resting and feeding habitats throughout the North Sea,

- high levels of mobility, including during the rearing of young birds, and
- the high spatial and temporal variability of the occurrence, which has been observed on a number of occasions.

It appears that guillemots actively track shoals of fish in this area. It is therefore not possible to define any particular function of the areas described here as feeding or rearing areas based on previous findings.

2.9.3 Status assessment of seabirds and resting birds

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

2.9.3.1 Importance of areas and sites for seabirds and resting birds

Areas N-1, N-2, N-3

For breeding birds, areas N-1, N-2 und N-3 are of no importance due to the distance from the coast and the islands, with the breeding colonies as feeding grounds.

Bird species listed in Annex I of the Birds Directive, such as divers, terns and little gulls, use the region around areas N-1, N-2 and N-3 as feeding grounds to only an unexceptional extent, predominantly during the migratory periods. For these, the region in the vicinity of areas N-1, N-2 and N-3 is not part of the valuable resting habitats or preferred staging points in the German Bight. The average importance of the areas for seabirds and resting birds results from the assessment of the rareness, vulnerability, uniqueness, diversity and naturalness of the seabird population in the area between the traffic separation areas in the German Bight.

The abundance and distribution of seabirds within the three areas demonstrate high levels of interannual variability specific to each species, small-scale variability occurring within the areas. The most common species are ship followers that benefit from fishing waste. Prior impacts from shipping, fishing and offshore wind farms in the vicinity of areas N-1, N-2 and N-3 are of medium to occasionally high intensity for seabirds. However, there is no contamination from fishing within the areas due to a ban on fishing at the offshore wind farms. According to the latest information available, the three areas N-1, N-2 and N-3 are of medium importance to resting birds and birds searching for food.

Area N-4

Area N-4 is located in the immediate vicinity of the "Sylt Outer Reef – Eastern German Bight" conservation area and in the southernmost part of the main concentration area of divers in the German Bight in spring (BMU 2009). The region in the vicinity of area N-4 is therefore of major importance to divers, even though the densities are mostly lower than those observed in the conservation area and the areas northwest of area N-4.

The region in the vicinity of area N-4 is also of major importance to the resting and migratory bird species to be protected in the conservation area. Other bird species listed in Annex I of the Birds Directive, such as terns and little gulls, occur in unexceptional numbers in area N-4. The abundance and distribution of seabirds within the area demonstrate a high level of interannual variability, depending on the species. The area is of medium to major importance as a feeding ground, depending on the species. Prior impacts from shipping, fishing and offshore wind farms in this area are of medium to seasonally high intensity for seabirds. In the sites of area N-4, however, prior impacts due to fishing are classified as very low due to a ban on fishing at the wind farms. For breeding birds from the breeding colonies on Helgoland and the islands off the North Frisian coast, area N-4 is of only minor importance as a feeding ground due to the distance from the breeding colonies.

Area N-5

All previous findings point to the major importance of area N-5 for seabirds.

For red-throated divers and black-throated divers listed in Annex I of the Birds Directive, the region in the vicinity of area N-5 is of very high importance. All subareas are located in the main concentration area for divers in the German Bight in spring (BMU 2009). To the east of area N-5 is subarea II of the Sylt Outer Reef – Eastern German Bight conservation area (Ordinance of 27 September 2017, Federal Law Gazette Part I No. 63, 3423). A high occurrence of other protected seabird species has also been observed here, depending on the season and species. Other bird species listed in Annex I of the Birds Directive, such as terns and little gulls, also occur in area N-5.

Area N-5 and its surroundings are located in the transitional area of the distribution area of many coastal bird species – including diving sea ducks – within the bird reserve, in addition to an increasing population of deep-sea bird species west of the area. The abundance and distribution of bird species within the area demonstrate a high level of interannual variability, depending on the species. The region in the vicinity of the area is of medium, but at times also major importance as a feeding ground for many deep-sea bird species. For divers, area N-5 is of high importance as a feeding ground before their vernal migration into breeding grounds.

For breeding birds, area N-5 is of only low importance due to the distance from the coast and the islands, with the breeding colonies as feeding grounds. Prior impacts from shipping, fishing and offshore wind farms in and around area N-5 are of medium to high intensity for seabirds.

Areas N-6 to N-13

All previous findings indicate that the areas north of the traffic separation areas are of medium importance to seabirds. Overall, the areas have a medium seabird population. The areas most frequently used by deep-sea bird species, including ship followers that benefit from bycatch, are those that are widespread throughout the North Sea.

Species such as divers that are susceptible to disturbance are only present in the areas for a short period as they search for food, and during the main migration periods. The areas are located outside the main distribution area for divers in spring. The areas are not among the valuable resting habitats or preferred staging points in the German Bight for other seabird species listed in Annex I of the Birds Directive that are particularly worthy of protection. The abundance and distribution of seabirds within the areas demonstrate a high level of interannual variability, depending on the species. The areas are of medium importance as feeding grounds for seabird species. Areas N-6 to N-13 are of no importance for breeding birds due to the distance to the coast. The prior impacts of shipping and fishing in the areas are of medium to sometimes high intensity for seabirds. The prior impact from offshore wind farms in areas N-6 to N-13 can generally be regarded as low due to the development of individual areas (N-6 and N-8) to date.

2.9.3.2 Protection status

Within the German North Sea EEZ, subarea II of the "Sylt Outer Reef – Eastern German Bight" conservation area (Ordinance of 27 September 2017, Federal Law Gazette Part I No. 63, 3423), which was established by ordinance of 22 September 2017, is home to significant numbers of important resting bird species. The classification of the most important resting bird species into national and international threat categories is summarised in Table 9 below.

Table 9: Assignment of the most important resting bird species of the German EEZ in the North Sea to European Red List threat categories. Definition according to IUCN: LC = Least Concern; NT = Near Threatened; VU = Vulnerable; EN = Endangered; CR = Critically Endangered.

English name (*scientific name*)	**Annex I of the Birds Directive[1]**	**Red List (Europe)[2]**	**Red List (EU27)[2]**
Red-throated diver *(Gavia stellata)*	X	LC	LC
Black-throated diver *(Gavia artica)*	X	LC	LC
Northern fulmar *(Fulmarus glacialis)*		EN	VU
Northern gannet *(Morus bassanus)*		LC	LC
Common 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
Black-legged kittiwake *(Rissa tridactyla)*		VU	EN
Sandwich tern *(Thalasseus sandvicensis)*	X	LC	LC
Common tern *(Sterna hirundo)*	X	LC	LC
Arctic tern *(Sterna paradisea)*	X	LC	LC
Guillemot *(Uria aalge)*		NT	LC
Razorbill *(Alca torda)*		NT	LC

[1] Annex 1 of the Birds Directive

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

The data basis for the occurrence of divers in the German Bight is classified as very good. The population in the entire German North Sea is estimated at 3,900 individuals for the winter (1 November to 29 February) (MENDEL et al. 2008). In spring (species-specific, 1 March to 30 April), when the occurrences are more prevalent, there are 1,600 individuals in the black-throated diver population (GARTHE et al. 2015), or 22,000 individuals in the more dominant red-throated diver population, according to current calculations (SCHWEMMER et al. 2019). A main concentration area of divers was defined in the German Bight based on all available data from environmental impact studies for offshore wind farms, from research projects and from Natura 2000 monitoring (BMU 2009). This area takes into account spring, the most important period for the species.

The main concentration area comprises all areas of very high diver density and most of the areas with high diver density. Based on the data available at the time the main concentration area was defined in 2009, the main concentration area was home to about 66% of the German North Sea diver population and about 83% of the EEZ population in spring and is therefore of particular importance in terms of population biology (BMU 2009). The importance of the main concentration area for divers in the German North Sea and within the EEZ has increased further against the background of current population calculations (SCHWEMMER et al. 2019). More detailed analyses and further studies indicate that diver populations are subject to high temporal and spatial dynamics. Use of the various parts of the main concentration area can be correlated with the also very dynamic frontal systems in the eastern German Bight (SKOV & PRINS 2001, HEINÄNNEN et al. 2018). The delimitation of the main concentration area to the west and southwest was selected in such a way as to include all important and known regular occurrences. However, irregular occurrences can be found again and again – particularly during the vernal migration of the species from the wintering areas to the breeding grounds – west of the boundary of the main concentration area and also in the EEZ north of the East Frisian Islands, although they should not belong to 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 constant (GARTHE et al. 2015, IFAÖ et al. 2016, IFAÖ et al. 2017). Current analyses show a larger occurrence southeast of area N-3 (GARTHE et al. 2018).

2.9.3.3 Hazards

As part of the marine ecosystem, seabirds are also exposed to threats. Changes in the ecosystem may be associated with threats to seabird populations. The following contributory effects can cause changes in the marine ecosystem, and hence in seabirds as well:

- ***Climate change***: Changes in water temperature are associated with changes in water circulation, plankton distribution and the composition of fish fauna. Plankton and fish fauna provide seabirds with food. However, it is hardly possible to predict the effects of climate change on seabirds due to uncertainty with regard to the effects of climate change on individual ecosystem components.
- ***Fishing***: Fishing can be expected to have a significant impact on the composition of the seabird community in the EEZ. Fishing can lead to a reduction in the supply of food and

may even lead to limits on food. Selective catching of fish species or fish sizes can lead to changes in the food supply for seabirds. Fishing discards provide additional food sources for some seabird species. The resulting trend towards more birds (lesser black-backed gull, European herring gull, common gull and black-headed gull) was identified by targeted studies (GARTHE et al. 2006).

- ***Shipping***: Shipping traffic has a significant deterrent effect on species susceptible to disturbance, such as divers (MENDEL et al. 2019, FLIESSBACH et al. 2019), and also includes the risk of oil spills.
- ***Technical structures*** (offshore wind turbines, platforms): Technical structures can have similar effects to shipping on species susceptible to disturbance. This also includes an increase in the volume of shipping traffic due to supply journeys, for instance. There is also a risk of collision with such structures. Furthermore, seabirds may be endangered by eutrophication, accumulation of pollutants in marine food chains and floating waste, e.g. parts of fishing nets and plastic parts. Epidemics of viral or bacterial origin also pose a threat to resting bird and seabird populations.

In summary, it can be stated that the seabird community of the German North Sea EEZ is clearly subject to anthropogenic influences, in particular from fishing and shipping traffic. The seabird community in the EEZ cannot be regarded as natural, for the reasons stated here.

2.10 Migratory birds

Bird migration is usually defined as periodic migrations between the breeding ground and a separate staging area outside the breeding period, which normally includes wintering grounds in the case of birds of higher latitudes. As bird migration takes place annually, it is also referred to as annual migration – and is distributed worldwide. In this context, we also refer to two-way migrators, birds that make a round trip, or annual migrators, birds that migrate annually. In addition to a resting destination, one or more intermediate destinations are often visited for the purposes of moulting, to visit favourable feeding grounds, or for other reasons. It is possible to tell long-distance and short-distance migrators apart by the distance covered and according to physiological criteria.

2.10.1 Data availability

Surveys of bird migration over the southeastern North Sea were performed on Helgoland as early as the 19th century (Gätke 1900). Long-term series of observations on migratory phenology and species-specific changes are available, particularly with regard to species whose habitat requirements are met by the "catching garden" on Helgoland (where birds are captured and ringed) (HÜPPOP & HÜPPOP 2002, 2004). In addition, visual observations and surveys at coastal sites (e.g. HÜPPOP et al. 2004, 2005) and visual observations carried out at various offshore sites provide quantitative data on bird migration (MÜLLER 1981, DIERSCHKE 2001).

The accompanying ecological research and environmental impact studies (EISs) 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 fundamental work. Particularly noteworthy here are the bird migration surveys at FINO1, which began in 2003 and largely permit continuous radar measurements of bird migration in offshore areas under constant conditions. Extensive results were published in the reports BeoFINO (OREJAS et al. 2005) and FINOBIRD (HÜPPOP et al. 2009). Besides radar studies, the accompanying research also includes thermal image recordings, continuous migratory call recordings and bird migration plan observations so as to do justice to the recordability of the species, which is of varying quality in terms of the specific methods used. Bird migration plan observations are also carried out that compare coastal and offshore locations such as Sylt, Wangerooge and Helgoland (HÜPPOP et al. 2004, 2005, 2009). With the exception of thermal imaging, the methods are also used in environmental impact studies (EISs) and monitoring of construction and operation, although no continuous monitoring is carried out in this regard. In addition, historical data on bird approach and collision events 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. As part of the accompanying ecological research, further evaluations of such records were also carried out on lighthouses and lightships in the German Bight (BALLASUS 2007).

2.10.2 Spatial distribution and temporal variability of migratory birds

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

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

Seasonal migration intensity is closely linked to species-specific or population-specific life cycles (e.g. BERTHOLD 2000). Besides these largely endogenously controlled annual rhythms in migration activity, the specific course of migration activity is determined primarily by weather conditions. Weather factors also influence the altitude and speed at which animals move. In general, birds wait for favourable weather conditions (e.g. tailwind, no precipitation, good visibility) before migration in order to optimise their efforts in terms of energy. This means that bird migration is concentrated on individual days or nights in autumn or spring. According to the results of an R&D project (KNUST et al. 2003), half of all birds migrate on just 5 to 10% of all days. Furthermore, the intensity of migration is also subject to daily fluctuations. About two-thirds of all bird species migrate predominantly or exclusively at night (HÜPPOP et al. 2009).

Broad-front migration is mainly typical for birds that migrate at night, but for songbirds that migrate during the day as well. Whether its intensity decreases according to the distance from the coast is not clear for the bulk of songbirds that migrate at night. According to migratory plan observations, some songbirds that migrate primarily during the day have a lower migration intensity on Helgoland than on Sylt or Wangerooge (HÜPPOP et al., 2009). For the migration of shorebirds, radar measurements confirm decreasing intensity towards the offshore area (DAVIDSE et al., 2000; LEOPOLD et al., 2004; HÜPPOP et al., 2006). The comparative studies by DIERSCHKE (2001) of the visible day migration of waders and water birds between Helgoland and the (former) North Sea Research Platform (FPN) 72 km west of Sylt also indicate a gradient between the coast and the open North Sea. This assumption is confirmed in the final BeoFINO report, as the results of the visual observations show a clear concentration of water birds near the coast. Only a few bird species (e.g. red-throated diver, pink-footed goose) are found in the offshore area in equal or larger numbers of individuals. The migration of songbirds is also more concentrated on the coast than in the offshore area (OREJAS et al., 2005, S.136).

However, reliable information on the magnitude of the decrease cannot be obtained due to the methodological requirements. Uncertainties in the visual observations result from a lack of information about the proportion of migrations at higher altitudes, for example. Furthermore, species such as the red-throated diver and the pink-footed goose, which are observed in Helgoland with the same or higher numbers of individuals than in the case of Sylt or Wangerooge, also appear among water birds (HÜPPOP et al., 2005, 2006). Table 7 solely illustrates the differences in the visible migration for Helgoland, Sylt and Wangerooge according to HÜPPOP et al. (2009), summed up for all species. Hence the intensity of bird migration on Helgoland is less reduced in autumn than in spring. A certain contribution by local resting birds to relatively high intensities on Wangerooge and Sylt cannot be ruled out. It should also be borne in mind that the difference that exists for songbirds should be significantly weaker if night migration is also taken into account.

Table 10: Mean migration intensity (individuals/h) over sea in the first three hours after sunrise for all species together at three locations – Wangerooge, Helgoland and Sylt – for spring and autumn (HÜPPOP et al., 2009).

Sea watching	Spring	Autumn
Wangerooge	598.4	305.9
Helgoland	144.3	168.8
Sylt	507.2	554.2

Although the migration intensity of selected species and groups of species decreases further away from the coast, there is broad-front movement across the open sea. It should again be noted that pronounced night migrators – for which barely anything is known at present with regard to decreasing migration intensity according to distance from the coast – have a special status. On FINO1, at least, far fewer night migrators than on Helgoland are recorded by radar (HÜPPOP et al. 2009). Finally, the numbers of individuals at the North Sea Research Platform and the *Buchan Platform* documented in individual migratory nights – > 100,000 and 150,000 songbirds (primarily thrushes) – in the central North Sea should also be emphasised (MÜLLER 1981, ANONYMUS 1992). They provide evidence of mass migration far from the coast and argue, at least temporarily, against pronounced gradients of migration intensity in these species. The frequency of such mass migration in the offshore area and the total proportion of the migration of a biogeographical population attributable to this have not been clarified as yet (BUREAU WAARDENBURG 1999; HÜPPOP et al. 2006).

2.10.2.1 Bird migration over the German Bight

Bird migration over the German Bight is documented all year round by means of various methods (radar, sea watching, migratory call recording), with strong seasonal fluctuations occurring and concentrations in spring and autumn. The German Bight is crossed synchronously (broad-front migration). According to EXO et al. (2002), many birds cross the North Sea on a broad front.

EXO et al. (2003) and HÜPPOP et al. (2005) reckon the number of birds migrating across the German Bight each year stands at tens to hundreds of millions. Songbirds, most of which cross the North Sea at night, represent the largest percentage (HÜPPOP et al. 2005, 2006). The mass of birds comes from Norway, Sweden and Denmark. For water birds and waders, however, the breeding grounds extend a long way northeast into the Palaearctic, and to Spitzbergen, Iceland and Greenland to the north and northwest.

Estimates of the annual migration volume over the North Sea by BUREAU WAARDENBURG (1999) for a larger selection of species involved in migration confirm these general assumptions. For a total of 95 selected species, BUREAU WAARDENBURG (1999) estimates a minimum of > 40.91 million and a maximum of

> 152.15 million birds that migrate across the North Sea every year.

The German Bight is located on the migratory route of numerous bird species. Between 1990 and 2003, between 226 and 257 (on average 242) species per year were recorded on Helgoland (according to DIERSCHKE et al. 1991–2004, quoted in OREJAS et al. 2005). Other species that migrate at night but do not call or call infrequently, such as the European pied flycatcher, should also be included (HÜPPOP et al. 2005). If rare birds are also taken into account, a total of more than 425 migratory bird species have been identified on Helgoland over a period of several years (HÜPPOP et al. 2006). Further away from the coast, the average migration intensity and, possibly, the number of migratory species seem to decrease (DIERSCHKE 2001).

Night migration is particularly pronounced in spring, from mid-March to May, and in autumn (October and November) (HÜPPOP et al. 2005, AVITEC RESEARCH GBR 2015). Nocturnal observations from the former North Sea Research Platform and the island of Helgoland confirm that nocturnal bird migration during the main migration periods is focused on nights with favourable migration conditions and then takes the form of mass migration. In spring, more than 50% of the migration detected by radar was identified over just 11 nights; while in autumn 2003 and 2004, more than 50% of the migration detected was identified on five out of 31 and six out of 61 nights respectively (HÜPPOP et al. 2005). Low intensities are observed from December to February, and from June to August.

Migration intensity follows a pronounced daily rhythm. Results from automatic migration call recording on FINO1 show increasing migration activity during evening and night hours, which reaches a peak in the early morning (HÜPPOP et al. 2009, HILL & HILL 2010). During the migration plan observations, the highest migration intensity was also observed in the early hours of the morning and then ebbed towards noon (HILL & HILL 2010, AVITEC RESEARCH GBR 2015). The manifestation of this rhythm may vary depending on the location and season.

Figure 32: Diagram showing main migration routes over the southeastern North Sea (shown for autumn, from HÜPPOP et al. 2005a) shows a detailed section of the broad-front migration over the southeastern North Sea. It should be emphasised here that the distances between the lines of individual migration flows merely indicate the direction of a gradient. A decrease in migration intensity further away from the coast appears to be documented for several day migrators, as well as water birds and waders. However, in the case of nocturnal songbirds – which dominate migration as a whole – it is not clear whether the broad-front migration typical for this group decreases further away from the coast, in which species and to what intensity (HÜPPOP et al. 2005a). Therefore, no conclusions about the magnitude of spatial trends should be drawn from Figure 17. Differences in intensity between the migration flows are also illustrated only qualitatively by the thickness of the lines.

According to what is known at present, seasonal northeast-southwest or southwest-northeast migration dominates widely (see Fig. 17), although there may be certain differences in the direction of migration and the degree of coastal orientation. HÜPPOP et al. (2009) and AVITEC RESEARCH GBR 2015 also identified a clear main migration direction to the south-southwest in their studies using radar on the FINO1 research platform in autumn (autumnal migration) (see Fig. 18). However, the results only reflect the situation when the weather is good. A clear direction (northeast) was recognisable in spring, but only at night when no birds seeking food were active.

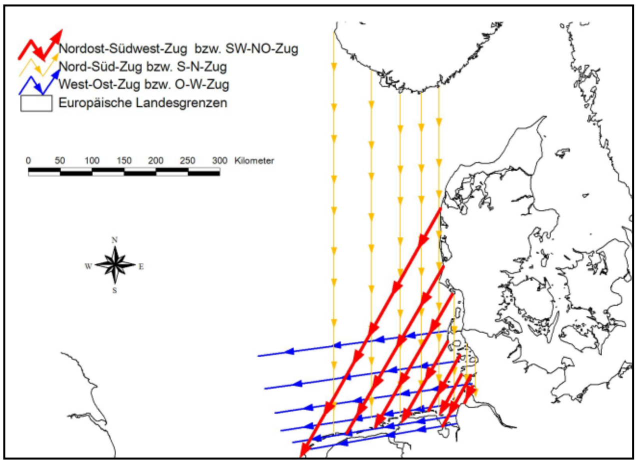


Figure 32: Diagram showing main migration routes over the southeastern North Sea (shown for autumn, from HÜPPOP et al. 2005a)

Radar recordings at the EIS sites also confirm this main direction of migration, but there are indications of certain variations in the direction of migration for each location. In northern offshore areas (area 5), larger migration percentages were observed heading for the south in autumn and the north in spring. However, the EIS observations took place over brief time frames. Further statements on spatial differences in the proportion of migration directions deviating from the main migration direction northeast to southwest are therefore not possible at present (HÜPPOP et al. 2005a).

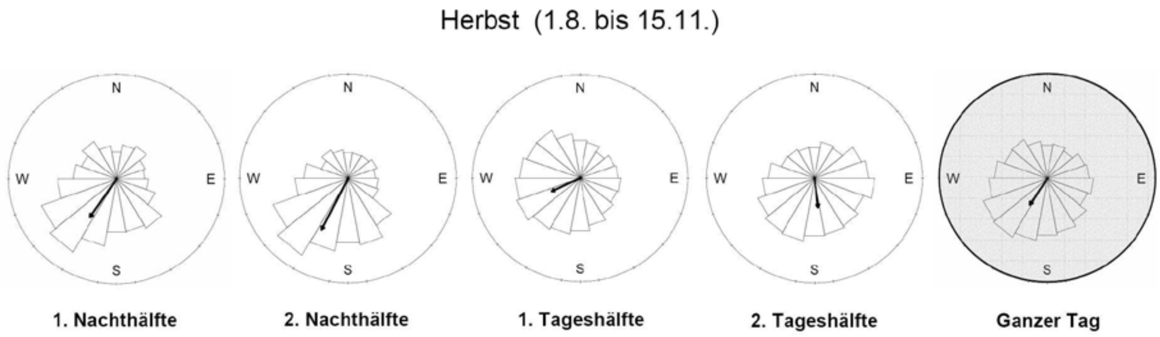


Figure 33: Relative proportions of flight directions identified at the FINO1 research platform in autumn, for four times of day and for the day as a whole (grey), averaged over the period 2005 to 2007. The sum of the individual directional elements within the pie chart is 100%. The direction of the arrow in the centre of the circle indicates the mean flight direction, while the arrow length indicates its uniqueness (HÜPPOP et al. 2009).

The flight altitude distribution differs between the bright and dark phases. In the dark phase, the average flight or migration takes place at higher altitudes. The changes to the altitude distribution in the light or dark phase can also be attributed to the species in question or the behaviour of the species. As a rule, migratory bird species that fly at relatively high altitude occur primarily at night, while other, mostly lower-flying species (e.g. seabirds or gulls) stop flying at night and rest on water or land.

Most signals at FINO1 were recorded at altitudes of up to 100 m in all seasons. In summer, the high level of flight activity in this area was due mainly to individuals searching for food. The radar recordings in the "alpha ventus" test field also show more intensive use of the altitude classes below 200 m. In spring 2009, 39% of echoes were recorded in altitude classes up to 200 m, and as much as 41% of echoes in autumn 2009 (HILL & HILL 2010). The values determined by AVITEC RESEARCH GBR (2015) in 2014 for altitude classes up to 200 m are comparable, with 36.1%. Signals were increasingly recorded in the upper altitude classes at night, especially in spring. EASTWOOD & RIDER (1965) and JELLMANN (1989) also recorded higher flight altitudes in the North Sea area in spring than in autumn. However, migration above 1,500-2,000 m accounts for just a small proportion of migration activity (JELLMANN 1979). That said, migration altitude distribution can vary widely between individual nights and is strongly influenced by the weather conditions at the time (JELLMANN 1979, HÜPPOP et al. 2006).

2.10.2.2 Species composition

During the course of the year and throughout the migration phases, flight and migration activity in the light phase is governed mostly by groups of species that use the region as both a resting area and a transit area. Of these, gulls, terns and seabirds with the species/groups lesser black-backed gull, black-legged kittiwake, common gull, sandwich tern and common tern/Arctic tern, as well as gannets, achieve the highest dominance values and/or continuity levels. In the case of migratory bird species solely crossing the sea area, the majority of records relate to songbirds.

While songbirds cross the project area in fairly concentrated numbers and in a relatively targeted fashion in the main migration months, gulls are represented almost all year round. This occurrence is often related to fishing vessels or other ships.

With partially large populations, songbirds dominate migration overall. During the FINOBIRD project, 97 species were detected at FINO1 via automatically recorded and manually evaluated bird calls (N = 95,318 individuals) (HÜPPOP et al. 2009). Three-quarters of these were calls from songbirds, including thrushes. The meadow pipit, European robin, common chaffinch, goldcrest and Eurasian skylark were also represented frequently, in addition to the common starling. The second most common group of species, with 11%, was the group of terns (mainly sandwich terns). Thrushes also made the majority of recorded migration calls in the context of the "alpha ventus" migration call records (HILL & HILL 2010).

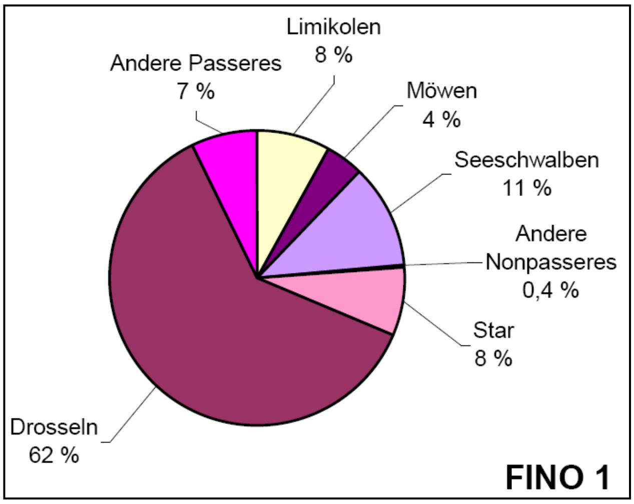


Figure 34: Proportions of species groups in all call recordings near the FINO1 research platform from 12 March 2004 to 1 June 2007 (HÜPPOP et al. 2012).

2.10.3 Status assessment of the factor Migratory birds

The assessment of the status of migratory birds as a protected asset in the German North Sea EEZ is based on the following assessment criteria:

- Guidelines and concentration ranges
- Migration movements and their intensity
- Number of species and threat status of the species in question.

Leading lines and concentration ranges

According to the latest information available, several tens to hundreds of millions of birds (max. 152 million) migrate across the German Bight every year. Songbirds, most of which cross the North Sea at night and on a broad front, represent the largest percentage. In this regard, it is not clear whether the intensity of the mass of the songbirds migrating at night decreases further away from the coast. Most of these birds come from Norway, Sweden and Denmark. However, in the case of songbirds migrating primarily during the day, there are indications of a decrease further away from the coast as the migration intensity on Helgoland is significantly lower than on Sylt (Hüppop et al. 2005). This trend is also confirmed by radar recordings for shorebird migration (Hüppop et al. 2006). The same appears to apply to water bird and wader migration (Dierschke 2001).

The definition of concentration ranges and leading lines for bird migration is not to be regarded as small-scale in the offshore region due to a lack of structures. Assessment of this criterion must take into account the large-scale course of bird migration in the North Sea.

Migration movements and their intensity

The migration intensity is immense, with estimated numbers of individuals ranging from 40 to 150 million, and it can be assumed that considerable numbers of songbirds breeding in Northern Europe migrate across the North Sea.

It is generally recognised that the offshore region of the North Sea is of great importance to bird migration, as it is assumed that large numbers of songbirds from Scandinavian populations cross the North Sea. Strong seasonal fluctuations in migration intensities are a characteristic feature of nocturnal bird migration, with a large proportion of migratory activity taking place in just a few nights. In addition to the BeoFINO and FINOBIRD research projects cited above, this link is also demonstrated regularly in the course of environmental impact studies for offshore wind farms and in the context of construction and operation monitoring.

Number of species and threat status of the species in question

The species composition of visible migration in the light phase in the region of the German Bight in 2003/2004 is estimated to total 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 Central European birds:

- Annex I of the Birds Directive,
- 1979 Bern Convention on the Conservation of European Wildlife and Natural Habitats,
- 1979 Bonn Convention on the Conservation of Migratory Species of Wild Animals,
- AEWA (African-Eurasian Waterbird Agreement),
- SPEC (Species of European Conservation Concern).

SPEC classifies bird species according to the proportion of the European population and the degree of threat as stated by BirdLife International.

Of the identified species, 20 are listed in Annex I of the Birds Directive: red-throated diver and black-throated diver, sandwich tern, common tern and Arctic tern, little tern and black tern, short-eared owl, western marsh harrier, hen harrier, osprey and merlin, little gull, European golden plover, ruff, wood sandpiper and bar-tailed godwit, barnacle goose, woodlark and bluethroat.

The composition of more than 200 species that migrate across the North Sea each year is average compared to the 425 migratory bird species that have been recorded on Helgoland over the years. However, a very high proportion of these have international protection status and are endangered throughout Germany. For these reasons, the North Sea EEZ is of average to above-average importance for bird migration in terms of species numbers and threat status.

2.10.3.1 Anthropogenic influences on bird migration

Anthropogenic factors contribute to the mortality of migratory birds in many ways and can influence population size and determine relevant migration activity in a complex interaction.

The significant mortality of migratory birds results from active hunting, collisions with anthropogenic structures, particularly those affecting night migrators, and – in the case of seabirds – from oil and chemical pollution of the environment (CAMPHUYSEN et al. 1999). The various factors act cumulatively, so that the isolated importance is usually difficult to determine. There is still a statistically insufficiently recorded proportion of hunting, particularly in Mediterranean countries (HÜPPOP & HÜPPOP 2002). TUCKER & HEATH (1994) conclude that more than 30% of European species affected by declining populations are also under threat from hunting.

2.10.3.2 Indirect losses

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

2.10.3.3 Climatic changes

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

2.10.3.4 Importance of areas and sites for migratory birds

The importance of the areas and sites for migratory birds in the German North Sea EEZ is determined by the following assessment criteria:

- Leading lines and concentration ranges
- Migration movements and their intensity
- Number of species and threat status of the species in question.

These three criteria are applied separately for areas 1-3, areas 4 and 5 and areas 6-13.

Leading lines and concentration ranges

Due to the lack of structures, it can be concluded that leading lines and concentration ranges for bird migration are not present in the EEZ, and therefore there are no differences between areas **N-1 to 13**.

Migration movements and their intensity

In the sea areas in which areas **N-1, 2 and 3** are located, almost all echoes were detected during both migratory periods based on whole migratory nights or days during the "Northern Borkum" cluster studies (AVITEC RESEARCH GBR 2017) in 2016. The main migration patterns were observed in spring (at the end of March and the end of April) and in autumn (in October and early November). This resulted in bird migration events of varying intensity up to mass migration on a long-term, location-specific scale. 142,764.6 bird movements (121 echoes/(h*km)) during the day and 265,039.5 bird movements (358 echoes/(h*km)) during the night were recorded for the entire spring season. In autumn, the corresponding values were 127,648 bird movements (129 echoes/(h*km)) during the day and 203,236 bird movements (217 echoes/(h*km)) during the night. A maximum of 3,535.6 echoes/(h*km) were recorded in spring, and 1,830.4 echoes/(h*km) were recorded in autumn. Migration intensities of an average of more than 1,000 echoes/(h*km) were determined in spring 2016 over a total of nine nights, and level was exceeded once during the day. In autumn, migration intensities of, on average, more than 1,000 echoes/(h*km) were recorded over just four nights.

In the "Northern Helgoland" cluster studies (IBL ET AL. 2017), the monthly average nightly migration rates ranged from 34 echoes/(h*km) in August 2016 to 423 echoes/(h*km) in March 2016 in the region of the **N-4** sea area. The mean migration rate over the entire period was 224 echoes/(h*km). The highest nocturnal migration rate was recorded in the night from 26 to 27 October 2016 (3,311 echoes/(h*km)). Migration rates were below 100 echoes/(h*km) on approximately 39% (spring) and 67% (autumn) of nights. 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 entire period was 93 echoes/(h*km). A total of nine nights with migration rates of more than 1,000 echoes/(h*km) occurred during the 2016 survey year (eight in spring, one in autumn). Thus the maximum migration rates are comparable to those seen on FINO1 ("Northern Borkum" cluster).

The measurements within the scope of the "West of Sylt" cluster survey (BioConsult SH 2017), which also cover the sea area **N-5** show that according to the results of the vertical radar, night migration is generally more pronounced than day migration. During autumnal migration in 2016, intensive bird migration was recorded primarily in October and November, while the months of July and August were expected to have lower migration intensities. Mass migration days were not detected during the autumnal migration: the maximum migration intensity was 120 echoes/(h*km) detected at the end of October. High migration intensities were recorded during vernal migration, mainly in March and April. The maximum value of 400 echoes/(km*h) was clearly above the maximum value of the autumnal migration. Bird migration was very irregular, particularly at night. For example, 72.5% of total vernal migration and 52.4% of total autumnal migration were recorded on the five nights with the highest migratory movements. High migration rates were achieved on just a few days, and bird migration was low on most of the days of the survey.

The available studies from the "Cluster 6" cluster survey from 2015 (Planungsgruppe Umweltplanungen 2017), as well as studies from the "East of Austerngrund" cluster survey (IfAÖ et al. 2017) from 2016 cover areas **N-6-8** and are used for evaluation. No relevant data is available for areas **N-9 to 13**, but the following explanations can be transferred as these are directly adjacent to areas 6-8 to the north.

Within the framework of the cluster 6 studies, nocturnal bird migration during the observation period (January 2015 to March 2016) showed strong fluctuations, with strong bird migration with average migration rates of more than 1,000 echoes/h/km occurring in just one night (18/19 October 2015). Maximum mean migration rates of approximately 700 echoes/h/km were recorded in spring. The migration rate was below 10 echoes/h/km on approximately 25% of the nights, and below 50 echoes/h/km on approximately 52% of the nights. The mean nightly migration rates per month ranged from 14 echoes/h/km (July 2015) to 358 echoes/h/km in October 2015. An average migration rate of 146 echoes/h/km was obtained for the period as a whole. The maximum hourly values varied between 104 echoes/h/km (July 2015) and 2,354 echoes/h/km (March 2015). A large difference between the mean and the median in the monthly values points to a strong spread in migration rates, especially in the months of April and October 2015. The seasonal distribution and intensity of the migration rates on the day following ship surveys are characterised by high levels of fluctuation. The highest migration rates in spring, with values of about 300 echoes/h/km, occurred on two days at the end of March and one day at the beginning of April 2015. In autumn, migration rates of more than 200 echoes/h/km were achieved in just one day (18 October 2015). The nocturnal migration rates determined by vertical radar within the "East of Austerngrund" cluster studies showed a high level of variation between the individual nights. The monthly mean values of the nightly migration rates were between 29 echoes/(h*km) (May 2016) and 361 echoes/(h*km) in October 2016, and reached an average value of 144 echoes/(h*km) over the entire period. Migration rates during the daytime were lower (mean: 84 echoes/(h*km)) and varied between 27 echoes/(h*km) in April 2016 and 125 echoes/(h*km) in October 2016. The mean migration rates at night were higher in spring (162 echoes/(h*km)) than in autumn (131 echoes/(h*km)), but the difference was not statistically significant. The daytime migration rates, on the other hand, differed significantly in comparison to the migration periods with higher migration rates in autumn (105 echoes/(h*km), strong migration days in August and October 2016 in particular than in spring (54 echoes/(h*km).

The relevant results of the migration intensities described above show roughly comparable results for all areas (**N-1 to 13**) in terms of the monthly mean. Differences can be seen in the maximum values. However, the fact that there is great interannual variability has to be taken into account.

These results are not in line with the general assumption of decreasing migration intensity further away from the coast, because under these circumstances the sea areas of area 6 (area 6 is located about 90 km northwest of the island of Borkum), for example, would be expected. With regard to proximity to land, area 6 is located in an area with low migration activity and migration rates should be lower than on Helgoland and the FINO1 platform, with a distance to land (or the island of Borkum) that is about twice as great as that of the "alpha ventus" wind farm and the FINO1 research platform (to be designated as being offshore). On the other hand, there is a maximum nightly migration rate of 1,206 echoes/h/km (measurements from the ship) and 3,330 echoes/h/km (platform) in this study. This comparison shows that very high maximum migration rates corresponding to FINO1 values can also occur in the offshore region of area 6. Further individual events also show, for example, the occurrence of more than 150,000 songbirds on individual nights at the North Sea Research Platform some 75 km northwest of Helgoland (MÜLLER 1981, quoted in PLANUNGSGRUPPE UMWELTPLANUNG 2017), indicating that temporary mass migratory events also occur far away from the coast. However, the recording of such mass migration events is subject to certain degree of uncertainty due to the discontinuous studies. Final deduction of a possible decrease in migration intensity further away from the coast is not possible at present.

Considering the very high migration rate over the German Bight, the individual sea areas **N-1 to 13** are of medium importance with regard to the migration intensity criterion.

Number of species and threat status of the species in question

Sea areas **N-1 to 13** do not differ significantly in terms of species numbers and threat status. Between 68 and 81 species were identified each year in the sea areas in the relevant studies for 2015 and 2016 referred to above. Of the species identified, 7-13 species are listed in Annex I of the Birds Directive. The observed numbers of species are assessed as average and the threat status is deemed to be above average.

Although leading lines and concentration ranges are lacking, sea areas **N-1 to 13** as a whole are of average to above-average importance for bird migration.

2.11 Bats and bat migration

Bats are characterised by very high levels of mobility. While bats can cover up to 60 km a day in search of food, nesting or summer resting places and wintering areas are several hundred kilometres apart. Migratory movements of bats in search of abundant food sources and suitable resting places are very frequently observed on land, but mainly aperiodically. However, migratory movements of bats across the North Sea are still scarcely documented and largely unexplored.

2.11.1 Data availability

The data basis on bat migration over the North Sea is not sufficient for a detailed description of the occurrence and intensity of bat migration in the offshore area. Reference is made below to general literature on bats, findings from systematic surveys on Helgoland and acoustic surveys from the FINO1 research platform and other sources of information in order to illustrate the latest information available.

2.11.2 Spatial distribution and status assessment

Bats are characterised by very high levels of mobility. Migratory movements of bats in search of abundant food sources and suitable resting places are very frequently observed on land, but mainly aperiodically. In contrast to irregular migratory movements, migratory movements take place periodically or seasonally. The migratory behaviour of bats is very variable. On the one hand, there may be differences depending on species and gender. On the other hand, migratory movements may vary greatly within the populations of a species. Based on their migratory behaviour, bats are divided into short-distance, medium-distance and long-distance migratory species.

Bats migrate over short and medium distances on their search for places to nest, feed and rest. Corridors along flowing waters and around lakes and shallow coastal waters are known for medium distances (BACH & MEYER-CORDS 2005). Long-distance migrations are still largely unexplored, however. There is very little in the way of descriptions of migratory routes of bats. This is particularly true of migratory movements across the open sea. In contrast to bird migration, which has been proven by means of 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 common noctule (*Nyctalus noctula*), the Nathusius' pipistrelle (*Pipistrellus nathusii*), the parti-coloured bat (*Verspertilio murinus*) and the lesser noctule Abendsegler (*Nyctalus leisleri*). Migrations over a distance of 1,500 to 2,000 km are recorded regularly for these four species (TRESS et al. 2004, HUTTERER et al. 2005).

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

Based on observations of bats on Helgoland, the number of bats migrating from the coast of Denmark across the German North Sea in autumn is estimated at about 1,200 individuals (SKIBA 2007). An evaluation of observations of bats migrating from southwest Jutland to the North Sea comes to the same conclusion (SKIBA 2011).

Although visual observations on the coast or on ships and offshore platforms, for example, provide initial indications, these are hardly suitable for full recording of the migratory behaviour of nocturnal bats across the sea. Detection of ultrasonic calls from bats by means of suitable detectors (known as "bat detectors") provides good results on land with regard to the occurrence and migratory movements of bats (SKIBA 2003). However, the results obtained to date from the use of bat detectors in the North Sea provide only initial indications. Acoustic surveys of bat migration over the North Sea performed on the FINO1 research platform revealed the detection of at least 28 individuals (HÜPPOP & HILL 2016) between August 2004 and December 2015.

When recording bat migration over the open sea, it is important to assess the possible risk of collision with offshore wind farms in addition to the general occurrence, species composition and migratory routes, as well as the heights at which bats migrate. The individuals surveyed by HÜPPOP & HILL (2016) were surveyed between 15 and 26 m at mean sea level on the basis of location and method, which includes the area between the lower rotor blade tip and the water surface at the majority of wind farms. BRABANT et al. (2018) investigated the bat population at the Thornton Bank wind farm using bat detectors at heights of 17 m and 94 m. Only 10% of the total of 98 bat images, and thus significantly less than at 17 m, were taken at higher altitudes.

Some species, such as the Nathusius' pipistrelle and the common noctule, are listed in Appendix II of the 1979 Convention on the Conservation of Migratory Species of Wild Animals (CMS), the "Bonn Convention". A total of 25 species of bat are native to Germany. In the current Red List of Mammals (MEINIG et al. 2008), two species were assigned to the category "indeterminate", four species to the category "critically endangered", and three species to the category "threatened with extinction". The common bent-wing bat *(Miniopterus schreibersii)* is considered "extinct or disappeared". Of the species that have been observed more frequently in the sea and coastal areas in Germany to date, the common noctule is on the Early Warning List, the common pipistrelle and the Nathusius' pipistrelle are considered to be "of least concern". The data situation is deemed to be deficient for assessment of the threat status of the lesser noctule.

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

2.12 Biodiversity

Biological diversity (or biodiversity for short) comprises the diversity of habitats and communities, the diversity of species and genetic diversity within species (Art. 2 of the Convention on Biological Diversity, 1992). Biodiversity is the focus of public attention. Biodiversity is the result of over 3.5 billion years of evolution, a dynamic process of extinction and species development. Of the approximately 1.7 million species described by scientists to date, some 250,000 occur in the sea, and although there are considerably more species on land than in the sea, the sea is more comprehensive and phylogenetically more developed than the land in terms of its phylogenetic biodiversity. Of the 33 recognised animal phyla, 32 are found in the sea, of which no fewer than 15 are exclusively marine (VON WESTERNHAGEN & DETHLEFSEN 2003).

Marine diversity is beyond direct observation and is therefore difficult to assess. Instruments such as nets, traps, grabs, traps or visual recording methods have to be used to assess these. However, the use of such devices can only ever provide a fraction of the actual species composition, exactly the species specific to the trap in question. As the North Sea, as a relatively shallow marginal sea, is more easily accessible than the deep sea, for example, intensive marine and fisheries research has been taking place for about 150 years, leading to an increase in knowledge about its fauna and flora. This makes it possible to use inventory lists and species catalogues to document possible changes (VON WESTERNHAGEN & DETHLEFSEN 2003). According to results from the Continuous Plankton Recorder (CPR), about 450 different plankton taxa (phytoplankton and zooplankton) in the North Sea are identified at the moment. About 1,500 marine species of macrozoobenthos are known. An estimated 800 of these are found in the German North Sea region (RACHOR et al. 1995). According to YANG (1982), the fish fauna of the North Sea comprises 224 fish and lamprey species. 189 species are reported for the German North Sea (FRICKE et al. 1995). In the North Sea EEZ, 19 seabirds and resting birds regularly occur in larger populations. Of these, three species are listed in Annex I of the Birds Directive. General information

With regard to the current state of biodiversity in the North Sea, there is a wealth of evidence of changes in biodiversity and species patterns at all systematic and trophic levels in the North Sea. Changes in biodiversity are due mainly to human activities, such as fishing and marine pollution, or to climate change.

In this regard, Red Lists of endangered animal and plant species have an important control and warning function as they indicate the state of populations of species and biotopes in a region. The Red Lists show that 32.2% of all currently assessed macrozoobenthos species in the North Sea and Baltic Sea (Rachor et al. 2013) and 27.1% of 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 endangered at present, the common bottlenose dolphin having already disappeared from the German North Sea region (von Nordheim et al. 2003). Of the 19 regularly occurring seabirds and resting birds, three species are listed in Annex I of the Birds Directive. In general, all wild native bird species are to be preserved and thus protected in accordance with the Birds Directive.

2.13 Air

Shipping generates emissions of nitrogen oxides, sulphur dioxides, carbon dioxide and soot particles. These can have an adverse impact on air quality and be discharged to a great extent into the sea in the form of atmospheric deposition. As of 1 January 2015, stricter regulations are applicable to shipping in the North Sea as an emissions monitoring area, known as the "Sulphur Emission Control Area (SECA). According to Annex VI, Regulation 14 of the MARPOL Convention, ships may only use heavy fuel oil with a maximum sulphur content of 0.10%. A limit value of 3.50% is still applicable worldwide at present. The International Maritime Organization (IMO) made a decision in 2016 to lower this limit to 0.50% worldwide by 2020.

Emissions of nitrogen oxides are of particularly relevance to the North Sea as an additional nutrient load. In this regard, the IMO decided in 2017 that the North Sea will be declared a "Nitrogen Emission Control Area" (NECA) as of 2021. The reduction of nitrogen oxide input into the Baltic Sea region through the North Sea and Baltic Sea ECA measure is estimated to stand at 22,000 t (European Monitoring and Evaluation Programme (EMEP 2016)).

2.14 Climate

The German North Sea is located in the temperate climate zone. Warm Atlantic water from the North Atlantic Current is an important influencing factor. Icing can occur in coastal areas, but it is rare and only occurs at intervals of several years. There is broad agreement among climate researchers that the global climate system is perceptibly influenced by the increasing release of greenhouse gases and pollutants, and that the first signs of this can already be seen.

According to reports by the Intergovernmental Panel on Climate Change (IPCC 2001, 2007), an increase in sea surface temperature and average global sea levels are expected to be the large-scale consequences of climate change on the oceans. Many marine ecosystems are sensitive to climate change. Global warming is also expected to have a significant impact on the North Sea, through both a rising sea level and changes in the ecosystem. In recent years, for example, there has been an increase in the spread of species that were previously found only further to the south, along with significant changes to the habits of long-established resident species.

2.15 Scenery

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

Buildings are platforms and measuring masts for research purposes which are located inside or in the immediate vicinity of wind farms. In the future, the landscape will continue to change due to the expansion of offshore wind energy; and the necessary navigation lights may also impair the visual appearance of the landscape. The objective of spatial planning No. 3.5.1 (8) according to the Maritime Spatial Plan for the German Exclusive Economic Zone in the North Sea (AWZ Nordsee-ROV) provides for a height limit of 125 m for wind turbines within sight of the coast and islands.

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

This is defined by the visual link between a building and its surroundings, the intensity of an effect decreasing further away (GASSNER et al. 2005).

In the case of platforms and offshore wind farms or areas planned at a distance of at least 30 km from the coastline, there is not much of an impact on the landscape as perceived from land. The platforms and wind farms will not be very visible at such a distance, even when visibility is good. This also applies to navigation lights for safety purposes at night.

2.16 Cultural heritage and other material assets

There are indications of possible material assets or cultural heritage insofar as the spatial location of a large number of wrecks is known on the basis of the evaluation of existing hydroacoustic recordings and the BSH wreck database, and recorded in BSH navigation charts. No further information is available on archaeological monuments in the EEZ, such as remains of settlements.

2.17 Human beings, including human health

All in all, the planning area for which the Site Development Plan defines specifications is of minor importance to the community as a protected asset. In a broader sense, maritime space represents the working environment for people who work on ships. Precise numbers of people who are regularly to be found in the area are not available. The importance as a working environment can be regarded as rather low.

Direct use for recreation and leisure purposes by leisure boats and tourist watercraft is merely occasional. As the North Sea EEZ as a whole is of only minor importance for active recreational use and as a working environment, the prior effects can be described as low. It is not possible to deduce the special significance of the planning areas for human health and well-being.

2.18 Interrelationships between the factors

The components of the marine ecosystem, from bacteria and plankton to marine mammals and birds, influence one another via complex processes. The biological protected assets plankton, benthos, fish, marine mammals and birds, as described individually in chapter 2, are dependent upon one another within the marine food chains.

Phytoplankton serve as a food source for organisms that specialise in filtering water for their food. The most important primary consumers of phytoplankton are zooplanktonic organisms such as copepods and water fleas. Zooplankton play a key role in the marine ecosystem as a primary consumer of phytoplankton on the one hand, and as the lowest secondary producer within the marine food chains on the other. Zooplankton serve as food for secondary consumers in marine food chains, from carnivorous zooplankton species to benthos, fish, marine mammals and seabirds. What are known as predators are among the top components of the marine food chains. Water birds, seabirds and marine mammals are some of the upper predators within the marine food chains. Producers and consumers are interdependent in the food chains and influence one another in many ways.

In general, the availability of food regulates the growth and distribution of species. Exhaustion of the producer results in the decline of the consumer. In turn, consumers control the growth of producers by eating. Food limitation has an impact at individual level by impairing the condition of individuals. At population level, food limitation leads to changes in the abundance and distribution of species. Food competition within a species or between different species has similar effects.

The temporally adjusted succession or sequence of growth between the various components of the marine food chains is of critical importance. For example, the growth of fish larvae is directly dependent on the available plankton biomass. The breeding success of seabirds is also directly related to the availability of suitable fish (species, length, biomass, energetic value). Temporal or spatial offset of the occurrence of succession and abundance of species at various trophic levels leads to interruption of food chains. Temporal offset, known as the trophic "mismatch", causes early developmental stages of organisms in particular to be undernourished, or even to starve to death. Interruptions in marine food chains can affect not just individuals, but populations as well. Predator-prey ratios or trophic relationships between size or age groups of a species or between species also regulate the balance of the marine ecosystem. For example, the decline in cod populations in the Baltic Sea had a positive impact on the development of European sprat populations (ÖSTERBLOM et al. 2006).

Trophic relationships and interactions between plankton, benthos, fish, marine mammals and seabirds are controlled by various control mechanisms. Such mechanisms work from the lower part of the food chains, starting with the availability of nutrients, oxygen or light and working up to the upper predators. A "bottom-up" control mechanism of this kind can work by increasing or decreasing primary production. Effects from upper predators downwards, via what are known as "top-down" mechanisms, can also control food availability.

The interactions within the components of marine food chains are influenced by abiotic and biotic factors. For example, dynamic hydrographic structures, frontal formation, water stratification and current play a crucial role in food availability (increase in primary production) and use by upper predators. Exceptional events such as storms and ice winters also affect trophic relationships within marine food chains. Biotic factors such as toxic algal blooms, parasite infestation and epidemics also affect the entire food chain.

Anthropogenic activities also have a decisive influence on interactions within the components of the marine ecosystem. Mankind affects the marine food chain both directly by catching marine animals, and indirectly through activities that may affect components of the food chains.

Overfishing of fish populations, for example, confronts upper predators such as seabirds and marine mammals with food limitations or forces them to develop new food resources. Overfishing can also cause changes at the bottom of the food chains. This can lead extreme jellyfish dispersion when their fish predators are removed by fishing. Moreover, shipping and mariculture are an additional factor that may lead to positive or negative changes in marine food chains through the introduction of non-native species. Discharges of nutrients and pollutants via rivers and the atmosphere also have an impact on marine organisms and may lead to changes in trophic conditions.

Natural or anthropogenic effects on one of the components of the marine food chains, e.g. the species composition or plankton biomass, can affect the entire food chain and shift and possibly endanger the balance of the marine ecosystem. Examples of the very complex interactions and control mechanisms within the marine food chains were presented in detail in the description of the individual protected assets.

The complex interactions between the various components ultimately lead to changes in the entire marine ecosystem of the North Sea. The changes as already described in Chapter 2 in relation to protected assets can be summarised as follows for the marine ecosystem in the North Sea:

- There have been slow changes in the living marine environment since the early 1980s.
- Rapid changes in the living marine environment have been observed since 1987/88.

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

3 Likely evolution without implementation of the plan

Expansion of offshore wind energy plays a key role in meeting the German government's climate protection and energy policy objectives.

Section 6 WindSeeG gives the Federal Maritime and Hydrographic Agency the task of compiling and updating a Site Development Plan for the EEZ under the conditions set out in section 4 ff. WindSeeG and, if an administrative agreement is concluded, also for coastal waters. The task of the plan, therefore, is to spatially define the areas and sites for wind turbines, the expected generation capacity there and the necessary routes and locations for the entire required grid infrastructure or grid topology in the North Sea EEZ. Furthermore, the plan also develops the temporal component of the expansion by determining the temporal sequence of the calls for tender for the sites for offshore wind turbines and the calendar years of the commissioning of connecting lines.

It is necessary to install offshore wind turbines in order to meet the expansion targets laid down in section 4 no. 2b of the Renewable Energy Sources Act. Even if the Site Development Plan were not to be implemented, further wind farms would still be built and commissioned in accordance with the applicable legal bases. The sectoral plan is used for spatially and temporally ordered, space-saving and efficient expansion of offshore wind energy in order to implement fragmentation by further application outside the areas, and hence to control land usage and thereby ensure minimal conflict in the development of this technology. Therefore, the environmental effects of the Site Development Plan's rules do not go beyond the effects of the zero alternative (non-implementation of the plan), but in fact can be reduced by the Site Development Plan on account of its steering effect.

According to section 17d subsection 1 sentence 1 of the Energy Industry Act, the responsible TSO must ensure the grid connection of offshore wind farms or, as of 1 January 2019, construct and operate them in accordance with the grid development plan and the Site Development Plan pursuant to section 5 of the Offshore Wind Energy Act.

It is absolutely necessary to lay the current-carrying submarine cable systems up to the grid connection points on land in order to allow the electricity generated at the offshore wind farms in the North Sea EEZ to be fed into the onshore high voltage grid. The need to connect offshore wind farms to the grid would exist even if the plan were not implemented. This means that even if the plan were not implemented, these uses would still be exercised in accordance with the applicable legal bases.

The TSO which is obliged to connect the offshore wind farms in the North Sea to the grid, is pursuing a connection concept based on high-voltage direct current (HVDC) transmission due to the required route lengths, which regularly exceed 100 km for the EEZ area. When using the HVDC, due to the relatively high system power, offshore wind farms are connected as a collective connection in which several offshore wind farms can be connected to an HVDC grid connection system consisting of a converter platform and submarine DC Subsea Cable - system. This means that a significantly smaller number of cable systems is required compared to a connection using three-phase current technology, thereby reducing the space required for the cable systems. As already explained, these sites are used for submarine cable systems and converter platforms independently of the implementation of the Site Development Plan in the EEZ. Therefore, the environmental effects of the Site Development Plan's rules do not go beyond the effects of the zero alternative (non-implementation of the plan), but in fact can be reduced by the Site Development Plan by way of steering.

The rule of the direct connection of wind turbines to the converter platform as a standard concept also leads to savings in terms of space required. This is due to the fact that transformer platforms are no longer necessary and may be omitted, but a separate platform may be required for maintenance and accommodation purposes for offshore wind farms. There could also be savings in terms of submarine cables, depending on the spatial location of the future converter platform.

The sites for the cabling within the wind farm will be used independently of the implementation of the Site Development Plan in the EEZ. The environmental impacts of the rules of the Site Development Plan do not therefore exceed the effects of non-implementation of the plan. Rather, the Site Development Plan may serve to mitigate them due to its steering effect.

The aim of the Site Development Plan is to specify the expansion of offshore wind turbines and the grid topology, in particular with regard to grid connection of offshore wind farms in the EEZ, coordinated in spatial and temporal terms according to the legal requirements in the sense of a predictive and coordinated overall planning. If the Site Development Plan were not to be implemented, the previously practised system of project-specific individual planning and connection would remain in place; in other words, wind farms and their grid connections would be planned and implemented without systematic inclusion of the entire area. The required space requirements can be minimised and the potential environmental impact can be reduced by regulating planning and technical principles in the Site Development Plan. As the plan makes numerous rules relating to the most compatible possible design of the uses, it would probably be more difficult to ensure the protection of the individual factors if the Site Development Plan were not implemented than if the plan were implemented.

The grid connection of the individual sites provided for in the plan, staggered in terms of time, has the potential to minimise disturbances to protected species in particular. Failure to implement the plan would probably increase area use and the associated burden on the marine environment. Inadequate spatial coordination in the event of non-implementation of the plan could, for example, lead to significantly more fragmented wind farm areas and cable crossings with corresponding effects – caused by intersections becoming necessary – on the factors in question.

Although it is not possible to quantify in concrete terms the number of additional land uses or crossings and the associated additional land requirements, it is clear from the rules in the Site Development Plan - in particular the areas for wind turbines, routing and gates - that the planning of the TSO has already progressed to such an extent due to the earlier system characterised by individual approvals and connections, that complete overall coordination is no longer possible due to existing constraints. Taking these constraints into account, a considerable number of crossings could no longer be prevented at this planning stage. For future projects, the aim is to coordinate these and to plan ahead in accordance with the planning principles (see details in chapter 5 of the Site Development Plan).

3.1 Soil/Area

Whether or not the plan were to be implemented, soil or land as a protected asset would be subject to heavy demands, in part due to various uses, such as fishing or the extraction of raw materials. Anthropogenic factors impact on the seabed through erosion, mixing, resuspension, material sorting, displacement and compression. The natural sediment dynamics (sedimentation/ erosion) and the mass transfer between sediment and seabed water are influenced in this way. Global warming is also leading to changes in hydrographic conditions. Overall, however, this development is independent of implementation or non-implementation of the plan.

During the construction phase of wind turbines, platforms and submarine cable systems, effects on the soil may result from direct disturbance of near-surface sediments, sediment resuspension, pollutant inputs and sediment rearrangements. The seabed is tightly sealed when the foundation elements of the converter platforms are installed. In the case of submarine cable systems, energy losses in the form of heat dissipation to the surrounding sediment may occur during operation. The potential effects of the planned wind turbines, platforms and submarine cable systems on soil as a protected asset are limited locally and are independent of the implementation of the plan.

Failure to implement the plan would be likely to result in less coordinated laying in spatial terms and, where applicable, a larger number of cable systems or longer submarine cable systems. This could lead to greater land use and thus to reinforcement of the possible effects on soil or land as a protected asset, compared with the implementation of the Site Development Plan. Moreover, an increased number of crossings of submarine cables in service could be expected if the plan is not implemented. This would make it necessary to increase the amount of rockfill even in areas with a predominantly homogeneous sandy seabed. Disused telecommunication cables are usually cut when they are crossed, so the cut ends of the cables would have to be secured with concrete weights to prevent them floating away. This would result in additional surface sealing and the introduction of artificial hard substrate.

3.2 Water

Water as a protected asset would be affected to an extent in the case of both implementation and non-implementation of the plan due to various uses, such as shipping or the extraction of raw materials. Moreover, it is to be expected that the warming of the water already triggered by climate change will continue in the future. Overall, however, this development is independent of the implementation of the plan.

Effects on the water body can occur during the construction phase of the converter platforms and submarine cable systems due to the resuspension of sediment, pollutant inputs and the formation of turbidity plumes. An increase in turbidity in the course of scouring cannot be ruled out around the foundations, for operational reasons. The potential effects of the planned converter platforms and submarine cable systems on water as a protected asset are limited locally and are independent of the implementation of the plan. As things stand at present, material emissions are not expected to have any significant effects on water as a protected asset. In principle, material emissions into the water body should be avoided as far as possible. Therefore, comprehensive examination of material emissions, among other things, must be carried out in the specific approval procedure. An emission study must provide a comprehensive description of all relevant emission pathways and examine technical alternatives, including avoidance and mitigation measures. Taking into account the environmental documentation to be submitted in the context of the individual approval procedure, the results of the emission study must be comprehensively evaluated with regard to any effects on the protected assets that could potentially be affected.

Failure to implement the plan would be likely to result in less coordinated laying in spatial terms and, where applicable, a larger number of submarine cables or longer submarine cables. This could lead to greater land use by the submarine cable systems, and thus to reinforcement of the possible effects on water as a protected asset, compared to implementation of the plan.

3.3 Plankton

Even if the plan were not implemented, phytoplankton and zooplankton as a protected asset would still be affected to an extent by the effects of various uses, such as fishing and shipping. Moreover, the effects of climate change on phytoplankton and zooplankton are now clearly noticeable (BEAUGRAND et al. 2003, WILTSHIRE & MANLY 2004). Phytoplankton and zooplankton species will be increasingly affected by possible effects of climate change in future, particularly to changes to temperature, salinity and current. Overall, however, this development is independent of the implementation of the plan.

The uses designated in the Spatial Offshore Grid Plan for the North Sea do not have a significant impact on plankton; so if the plan is not implemented, plankton will develop in the same way as if the plan were implemented. There may be small-scale, short-term effects on phytoplankton and zooplankton due to the formation of sediment turbidity plumes during the construction of converter platforms and the laying of submarine cable systems. However, significant effects on phytoplankton and zooplankton due to converter platforms and submarine cable systems can almost certainly be excluded due to the high dynamics of the hydrographic conditions in the EEZ. Effects on plankton can be excluded with the necessary certainty even during normal operation.

3.4 Biotopes

Even if the plan were not implemented, biotopes as a protected asset would still be affected to an extent by the effects of individual uses, such as fishing and the extraction of raw materials. Failure to implement the Site Development Plan would be likely to result in less coordinated spatial planning. Failure to implement the plan could lead to comparatively greater land use and thus reinforcement of possible effects on protected biotopes, compared to implementation of the plan. Possible effects on biotopes would result from installation of the foundations of the wind turbines and platforms and the laying of cable systems. During the construction phase, direct disturbance of near-surface sediments, pollutant inputs, resuspension of sediment, formation of turbidity plumes and an increase in sedimentation could all impact on sensitive biotope structures. The Site Development Plan formulates corresponding planning principles (e.g. planning principles 4.4.2.1, 4.4.3.1 and 4.4.4.9) for the special protection of biotopes and habitat types as referred to in section 30 of the Federal Nature Conservation Act.

The artificial hard substrate introduced with the foundations would result in local changes to the habitat, which could lead to a change in the species composition of the benthic communities. Failure to implement the plan would result in an increased number of crossings, which would also require the introduction of hard substrate. By reducing the number of cable routes and minimising the number of intersections, the specifications of the Site Development Plan aim to minimise land use as far as possible and give special consideration to protected biotopes. Therefore, if the plan were not implemented, protection of marine biotopes would probably be more difficult to ensure than if the plan were implemented.

3.5 Benthos

Even if the plan were not implemented, benthos as a protected asset would still be affected to an extent by the effects of various uses, such as fishing and the extraction of raw materials. Moreover, it is to be expected that the warming of the water already triggered by climate change will continue in the future. This will also have an impact on the benthos. This may lead to settlement of new species, or a shift in the species composition as a whole. However, this development is independent of implementation or non-implementation of the plan.

Failure to implement the Site Development Plan would be likely to result in less coordinated spatial planning of the wind farm and submarine cable systems. Failure to implement the plan could lead to comparatively greater land use and thus reinforcement of possible effects on the benthos, compared to implementation of the Site Development Plan. Possible effects on the benthos would result from installation of the foundations of the wind turbines and platforms and the laying of cable systems. During the construction phase, direct disturbance of near-surface sediments, pollutant inputs, resuspension of sediment, formation of turbidity plumes and an increase in sedimentation could all impact on benthic communities.

Changes in the existing species composition in the vicinity of the foundations of the installations and platforms may occur in the artificial hard substrate introduced as a result of the installations. Failure to implement the plan would result in an increased number of cable crossings or intersections that would also require the introduction of hard substrate. Here, too, there would be small-scale changes to the habitat structures which could in turn lead to a shift or change in the species composition of the benthos.

As the specifications of the Site Development Plan aim to minimise the use of the seabed by reducing the number of cable routes and minimising the number of intersections as far as possible, if the plan were not implemented it would probably be more difficult to ensure the protection of benthos than if it were implemented.

3.6 Fish

Fish as a protected asset would be affected to an extent by the effects of fishing in the case of both implementation and non-implementation of the plan. Moreover, regardless of the implementation or non-implementation of the plan, it is to be expected that the warming of the water already triggered by climate change will continue in the future. This will also have an impact on fish as a protected asset. This may lead to the immigration of new fish species; which may not necessarily result in competition with native fish species, but this cannot be ruled out. During the construction phase of the wind farms and converter platforms and the laying of submarine cables on the planned routes, fish fauna – e.g. species that hunt visually – may be impaired due to increased sedimentation and the formation of turbidity flags. Furthermore, fish may also be temporarily scared away by noise and vibrations during the construction phase. Further effects on fish fauna may be due to the additional hard substrates introduced owing to a possible change in the benthos. Failure to implement the plan would be likely to result in less coordinated laying of the submarine cable systems in spatial terms. This could lead to comparatively greater land use and thus to reinforcement of the potential effects on fish fauna compared to laying coordinated by the Site Development Plan. Therefore, without implementation of the Site Development Plan, protection of fish fauna would probably be more difficult to ensure than with its implementation.

3.7 Marine mammals

Even if the plan were not implemented, marine mammals as a protected asset would still be affected to an extent by the effects of various uses, such as shipping and fishing.

Marine mammals, in particular noise-sensitive harbour porpoises, could be affected by noise input during the installation of driven foundations for offshore wind turbines, transformer stations and converter platforms if no noise abatement measures are implemented. Alternative foundation methods are currently being developed, or trial phases have already begun in some cases, such as jacket-suction buckets.

Furthermore, a converter platform has already been erected on a gravity-based foundation. The operation of DC Subsea Cables is state-of-the-art for the distances required for connection of offshore wind farms in the North Sea EEZ.

The plan includes a whole series of planning principles relating to the most compatible design of uses possible, in particular a noise reduction principle and the exclusion of offshore wind farms and converter platforms in conservation areas. These principles will reduce adverse impacts on marine mammals.

Overall, however, the effects of the plan specifications on marine mammals will be comparable with the effects of the zero alternative, since project-specific and site-specific noise reduction measures are essentially arranged in the specific individual approval procedure, regardless of the implementation of the plan. The standardised technology specification laid down in the plan, according to which the converter platforms are to be designed to 900 megawatts (corresponding to the current state of the art), reduces the number of converter sites to a minimum in any case. A similar trend can also be seen in the plan's performance specifications and the resulting reduction in the number of installations. Failure to implement the plan would lead to an uncoordinated approach having to be assumed. The land might not be used in an economically and environmentally sound way for the construction and operation of offshore wind - turbines. Nor would it be possible to rule out the construction of more than the 25 converter platforms planned at present. Finally, the planned staggering of the grid connection of the individual areas has the potential to minimise overall disruptions to marine mammals.

The effects of natural variability on marine mammals as a consequence of climate change are complex and difficult to predict. All species will be indirectly affected by possible effects of climate change on their food organisms, fish. The possible relocation of harbour porpoise populations already referred to could also be linked to climate change. Overall, however, this development is independent of the implementation of the plan.

3.8 Seabirds and resting birds

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

Failure to implement the Site Development Plan would result in less spatially coordinated planning of wind farm projects, platforms and submarine cable systems. This would probably increase land use, which in turn could impact on species susceptible to disturbance. Furthermore, the Site Development Plan is based on planning principles which, in addition to spatial planning, also provide for temporal coordination of construction projects so as to be able to reduce temporary factors affecting seabirds and resting birds, such as additional shipping traffic due to construction.

Even if similar factors would have an impact on seabirds in principle regardless of whether or not the Site Development Plan is implemented, it would be more difficult to ensure the protection of seabirds and resting birds if it were not implemented due to a lack of planning principles and their coordinating requirements.

3.9 Migratory birds

Even if the plan were not implemented, resting birds and migratory birds as protected assets would still be affected to an extent, as shown, by the effects of various uses such as fishing and shipping. The effects of climate change on the affected species are complex and difficult to predict. All species will be indirectly affected by possible effects of climate change on their food organisms, particularly fish. Overall, however, this development is independent of implementation or non-implementation of the plan.

Failure to implement the Site Development Plan would primarily lead to increased use of the seabed due to uncoordinated individual connections of offshore wind farms and would not represent any additional or altered impairment of the avifauna. Moreover, the increase in shipping traffic due to construction/cable laying and maintenance would not exceed the level of shipping traffic generated during the implementation of the Site Development Plan. Additional construction and operational effects on avifauna are not to be expected. If the plan is not implemented, effects on resting birds and migratory birds as a protected asset are likely to develop in the same way as if the plan were implemented.

3.10 Bats and bat migration

Migration movements of bats across the North Sea are still scarcely documented and largely unexplored. There is a lack of specific information on migratory species, migration corridors, migration heights and migration concentrations. Information available to date confirms merely that bats, especially species that travel long distances, fly over the North Sea. However, some effects of climate change can be predicted on the basis of previous findings on factors such as the distribution and habitat preferences of bats. Loss of resting places along migratory routes, decimation of breeding habitats and changes in the food supply are examples of issues to be expected. The delayed occurrence of food in particular may have consequences for the reproductive success of bats (AHLEN 2002, RICHARDSON 2004). The observed insect mortality will have an increased adverse impact on bats.

Dangers to individuals due to collisions with wind farms or platforms cannot be ruled out. If the plan is not implemented, effects on bats as a protected asset are likely to develop in the same way as if the plan were implemented. It can also be expected that any negative effects on bats can be prevented by using the same prevention and mitigation measures devised to protect bird migration.

3.11 Biodiversity

Large-scale consequences of climate change can also be expected in the oceans. Many marine ecosystems are sensitive to climate change, so this will impact on biodiversity. There may be a shift in the species composition. A major influence on the population density and dynamics of fish would be conceivable, for example, which in turn would have significant consequences for the food chains. Overall, however, this development is independent of the implementation of the plan.

Temporary or permanent acoustic and visual stress may lead to impairment of individual fish, bird and marine mammal species. However, effects on biodiversity are currently unimaginable, as no loss of species is to be expected. Effects of turbidity plumes, sedimentation and sediment warming or magnetic fields on biodiversity are also unlikely, as these are usually local adverse impacts. It is also to be expected that the avoidance and mitigation measures planned for the individual protected assets will also reduce the possible adverse impacts on biodiversity.

The potential impact on biodiversity will be reduced further by excluding the construction of offshore wind farms and platforms in nature reserves. Local effects on the diversity of habitats and species cannot be ruled out in principle, and can even be expected in part due to the introduction of hard substrate. Overall, however, the benthic species settling here and any fish species that may be attracted as a result will be recruited from the immediate vicinity, so ultimately no large-scale changes in biodiversity are to be expected within the study area.

As the specifications of the Site Development Plan aim to reduce the use of the seabed as far as possible by reducing the number of cable routes and minimising the number of intersections, and as a number of principles serve to ensure that the design of the specifications is as environmentally friendly as possible, the effects on biodiversity can probably be reduced compared with the zero alternative.

3.12 Air

Shipping traffic in the North Sea will also increase as the intensity of use increases, which may have an adverse impact on air quality. However, this development is largely independent of implementation or non-implementation of the plan. The construction and operation of the platforms and the laying of submarine cable systems as part of the implementation of the Site Development Plan will have no measurable impact on air quality. If the plan is implemented, therefore, air as a protected asset will develop in the same way as if the plan were not implemented.

3.13 Climate

According to reports by the Intergovernmental Panel on Climate Change (IPCC 2001, 2007), an increase in sea surface temperature and average global sea levels are expected to be the large-scale consequences of climate change on the oceans. Many marine ecosystems are sensitive to climate change. Overall, however, this development is independent of implementation or non-implementation of the plan.

Adverse impacts on the climate from converter platforms are not expected, as there are no measurable emissions relevant to climate during construction or operation. Rather, the coordinated expansion of the grid infrastructure in the offshore region will create greater planning security for the expansion of offshore wind energy. The CO_2 savings associated with the expansion of offshore wind energy are expected to have a positive impact on the climate in the long term. This may make an important contribution to achieving the Federal Government's climate protection targets.

3.14 Scenery

Implementation of offshore wind farms will have an impact on the landscape as it will be altered by the construction of vertical structures. For safety reasons, the installations will also have to be illuminated at night or in poor visibility. This may also lead to visual impairments of the landscape. Section 3.5.1 (8) of the Spatial Development Plan for the North Sea stipulates a height limit of 125 m for wind turbines within sight of the coast and islands. This Maritime Spatial Development objective relates to land designations in zone 1 of the Site Development Plan.

The construction of platforms may also lead to visual changes in the landscape. The extent to which the landscape is affected by offshore installations depends largely on the prevailing visibility conditions, but also on subjective perceptions and the fundamental attitudes of observers towards offshore wind energy. The vertical structures, which are atypical for the familiar image of a seascape, may be perceived as disruptive, but some people will find them technically interesting. In any case, they will bring about a change in the landscape and modify the character of the area.

Due to the considerable distance of more than 30 km between the planned platforms and the coast, the installations will only be visible to a very limited extent from land, and only when visibility is good. This also applies to navigation lights for safety purposes at night.

The fact that a glare-free, low-reflection coating is required as standard for the approval of individual projects helps to minimise visibility. It is also necessary to take into account the fact that platforms are always planned in physical proximity or in spatial connection with offshore wind farms, so the change in the landscape will be increased only slightly by these individual structures in immediate physical proximity to the offshore wind farms.

Overall, the impact of offshore installations on the landscape can be classified as quite low.

The development of the landscape if the Site Development Plan is not implemented will probably not differ significantly from its development if the Site Development Plan is implemented. However, it should be noted that the space required can be minimised by the specifications of the Site Development Plan. The potential effects on landscape as a protected asset can thus be reduced to a minimum by spatially coordinated, forward-thinking and synchronised overall planning of the Site Development Plan. A lack of spatial coordination if the plan is not implemented could lead to significantly more fragmented wind farm areas and greater land use, as well as slightly increased visibility from the coast.

For the submarine cable systems, adverse impacts on the landscape during the operating phase can be ruled out as they will be laid as underwater cables.

3.15 Cultural heritage and other material assets

There are indications of possible material assets or cultural heritage insofar as the spatial location of a large number of wrecks is known and recorded in the BSH's nautical charts. Based on available hydroacoustic surveys and evaluation of the underwater obstacle database, there are no findings relating to material assets or cultural heritage in the region of the planned platform sites. There are individual underwater obstacles along the planned submarine cable routes, in the region between the traffic separation areas. Particular emphasis must be placed on these when taking them into account in the specific approval procedure. If any culturally significant finds or material assets are discovered during the prescribed site survey in the approval procedures for the territories and areas, the construction of platforms and the laying of submarine cables, appropriate measures must be taken to preserve them. The Site Development Plan provides a corresponding specification so as to ensure that this protected asset cannot be affected adversely. Under this condition, no significant effects on "Cultural heritage and other material assets" as a protected asset are to be expected, regardless of whether or not the Site Development Plan is implemented.

3.16 Human beings, including human health

Overall, the area for which the Site Development Plan is providing specifications is of little significance to human health and well-being. Mankind is not directly affected by the specifications of the plan, but at most indirectly by the perception of the landscape as a protected asset and possible influences on the recreational function of the landscape for water sports enthusiasts and tourists (see chapter 3.14 and 4.10). These effects are considered insignificant due to the considerable distance of more than 30 km from the coast. These effects do not go beyond the effects of the zero alternative.

3.17 Interrelationships between the factors

It is assumed that the interactions between the protected assets will develop in the same way regardless of whether or not the Site Development Plan is implemented. Therefore, reference is made at this point to chapter 2.18.

4 Description and assessment of the likely significant effects of the implementation of the Site Development Plan on the marine environment

The following description and assessment of the environmental effects concentrate on factors for which significant effects cannot be excluded from the outset by implementation of the Site Development Plan.

According to section 40 subsection 1 of the Environmental Impact Assessment Act, the likely significant environmental effects of the implementation of the plan are to be assessed. Furthermore, according to section 40 subsection 3 of the Environmental Impact Assessment Act, the environmental effects of the plan are being assessed provisionally with a view to taking effective environmental precautions. According to section 3 sentence 2 of the Environmental Impact Assessment Act, the environmental assessment serves to ensure effective environmental precautions in accordance with the applicable laws. Within the framework of the Site Development Plan and the provisions of sections 4 et seq. of the Offshore Wind Energy Act applicable in this respect, any danger to the marine environment must be eliminated in the specifications included in the plan pursuant to section 5 subsection 3 of the Offshore Wind Energy Act. The marine environment includes the protected assets and their habitats described in this environmental report, including possible interactions.

The factors for which significant impairment could already be excluded in the previous chapter 2 are not taken into account. This concerns the protected assets Plankton, Water, Air, Cultural heritage and other material assets and Human beings, including human health.

Possible effects on biodiversity as a factor are discussed for the individual biological factors. Overall, the protected assets listed in section 2 subsection 1 of the Environmental Impact Assessment Act will be examined before the wildlife conservation and legal territorial protection examinations are presented. Statements on the general protection of nature and landscape in accordance with section 13 of the Federal Nature Conservation Act are covered in the assessment of the individual factors.

4.1 Soil/Area

4.1.1 Areas, sites and platforms

Wind turbines and platforms are currently installed almost exclusively with deep foundations. However, the use of other foundation structures such as gravity foundations or suction bucket foundations can also be considered.

Deep foundation variant:
With 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 soil. Suction bucket foundations achieve stability by creating negative pressure in the cylindrical foundation structure, which does not have to be driven. Above the seabed, for both deep foundations and suction bucket foundations, a lattice frame structure made of steel tubes and struts, known as a jacket structure, is normally used to aid rigidity.

To protect against scouring, either scour protection in the form of mudmats or rockfills is applied around the foundation elements, or the foundation piles of deep foundations are inserted deeper into the soil.

Wind turbines and platforms have locally limited environmental impact with regard to soil as a protected asset. The sediment is only permanently affected in the immediate vicinity by the insertion of the foundation elements (including scour protection, where necessary) and the resulting land use.

Due to construction: Sediments are briefly agitated and turbidity plumes are formed during foundation work for wind turbines and platforms. If the foundations of installations or platforms are implemented as gravity foundations, preparatory construction measures are also necessary to ensure that the installations or platforms are stable. If levelling of the seabed is necessary, increased formation of turbidity plumes may occur depending on the fine grain content.

The extent of resuspension is essentially dependent on the fine grain content in the soil. As the surface sediments of the North Sea EEZ are mainly fine and medium sands, and sometimes coarse sands as well, the released sediment will settle quickly, directly at the construction site or in its immediate vicinity. The expected adverse impacts due to increased turbidity remain limited to small areas.

In the short term, pollutants and nutrients may be released from the sediment into the bottom water. The potential pollutant input into the water column due to agitated sediment is negligible due to the relatively low fine grain content (silt and clay) and the low pollutant load, as well as the relatively rapid resedimentation of the sands. This is also applicable given the fact that the sandy sediments are naturally agitated and relocated by waves touching the seabed and corresponding currents, e.g. during storms.

Effects in the form of mechanical stress on the soil due to displacement, compaction and vibrations, which are to be expected during the construction phase, are estimated to be low due to their small size. Excavation of construction pits may be necessary under certain circumstances as part of the preparations for the construction of gravity foundations. The movement of the resulting excavated soil will lead to impairment of additional areas.

Due to the installation, the seabed will be permanently sealed to only a limited extent by the installation of the foundation elements of wind turbines or platforms with deep foundations. The affected areas essentially comprise the diameter of the foundation piles with any necessary scour protection. The area requirement (for sealing) for transformer platforms and converter platforms, which are based almost exclusively on jacket structures (without scour protection), is approximately 600 m^2 to 900 m^2 depending on the size of the platform. Wind turbines are also installed almost exclusively with deep foundations.

By far the most common foundation variant here is the monopile. Land use of about 1400 m^2 including scour protection is achieved with a monopile diameter of 8.5 m. Land use for suction bucket foundations is approximately the same as that required for monopiles.

In the case of gravity-based platforms, the sealing of the area due to the nature of the installation is significantly greater than in the case of deep foundations. Including scour protection measures, ten to twenty times the area of a platform with deep foundations is expected to be used.

Due to operation, there may be interaction between the foundation and hydrodynamics in the immediate vicinity of the installation, and permanent agitation and rearrangement of the sandy sediments may occur. Scour formation may occur in the immediate vicinity of the installations. According to previous experiences, permanent sediment rearrangement caused by the current can only be expected in the immediate vicinity of the platform. According to the findings from the accompanying geological surveys for the "alpha ventus" offshore test field (LAMBERS-HUESMANN & ZEILER 2011) and the FINO1 and FINO3 research platforms, this will occur locally around the individual foundation piles (local scour). No significant substrate changes are to be expected due to the prevailing soil conditions and the forecast locally limited scour coverage.

Given the above statements, and taking into account the assessment of the situation whereby the seabed in the area surveyed is predominantly unstructured, with homogeneous sediment distribution involving fine and medium sands, the SEA has concluded that no significant effects on soil as a protected asset are to be expected from the specification of the installations or platform sites.

Area N 3.7 was designated with regard to economy in terms of area. Building on this site following the partial award of the project by the project developer, complete with the smaller capacity available, would mean a high level of land use with low capacity compared to the limited total space available in the EEZ.

4.1.2 Submarine cabling systems

Due to construction, the turbidity of the water column will increase as a consequence of sediment agitation when laying cables. This turbidity will be distributed over a larger area due to the influence of tidal currents. The extent of resuspension is essentially dependent on the laying procedure and the fine grain content in the soil. The predominant sediment composition in the North Sea EEZ means that most of the sediment released will settle directly at the construction site or in its immediate vicinity. The suspension content decreases again to the natural background values due to dilution effects and sedimentation of the whirled-up sediment particles. The expected adverse impacts due to increased turbidity remain limited to local areas. The results of surveys from various procedures in the North Sea show that the seabed will in part level off relatively quickly due to the natural sediment dynamics along the affected routes.

In the short term, pollutants and nutrients may be released from the sediment into the bottom water. The possible release of pollutants from the sandy sediment is negligible due to the low fine grain content and the low heavy metal concentrations in the sediment.

Effects in the form of mechanical stress on the soil due to displacement, compaction and vibrations, which are to be expected during the construction phase, are estimated to be low due to their small size.

Due to operation, the surrounding sediment will warm up radially around the cable systems in the case of both DC and AC submarine cable systems. Heat will be released due to thermal losses in the cable system during energy transmission.

These energy losses are dependent on a number of factors. The following output parameters have a significant influence:

- Transmission technology: in principle, more heat release due to thermal losses is to be assumed for AC submarine cable systems with the same transmission efficiency than for DC submarine cable systems (OSPAR Commission 2010).
- Ambient temperature in the vicinity of the cable systems: depending on water depth and season, variation in the natural sediment temperature can be assumed, which has an influence on heat dissipation.
- Thermal resistance of the sediment: predominantly water-saturated sands occur in the EEZ. A range from 0.4 to 0.7 KmW-1 is valid for the specific thermal resistance for these sands, taking various sources into account (Smolczyk 2001, Bartnikas & Srivastava 1999, VDI 1991, Barnes 1977). According to this, more efficient heat dissipation can be assumed for water-saturated coarse sands than for finer-grained sands.

Table 11: Thermal properties of water-saturated soils (according to SMOLCZYK 2001)

Soil type	**Thermal conductivity, minimum**	**Thermal conductivity, maximum**	**Specific thermal resistance, maximum**	**Specific thermal resistance, minimum**
	W / (K*m)	W / (K*m)	K*m / W	K*m / W
Gravel	2.00	3.30	0.50	0.30
Sand	1.50	2.50	0.67	0.40
Clay	0.90	1.80	1.11	0.56
Till	2.60	3.10	0.38	0.32
Silt / mud	1.40	2.00	0.71	0.50

Temperature development in the near-surface sediment layer is also dependent on the depth at which the cable systems are laid. According to available information, no significant effects from cable-induced sediment warming are to be expected if a sufficient laying depth is maintained and if cable configurations according to the state of the art are used. Various calculations relating to sediment warming due to the operation of submarine cable systems were presented as part of the environmental contributions for current-carrying cable systems of offshore wind farms. According to the applicant, the cable-induced sediment warming in the "BorWin 3 and BorWin gamma" project will amount to approximately 1.3 K at a sediment depth of 20 cm for the DC Subsea Cables if the cables are jetted to a depth of at least 1.50 m as specified in the Site Development Plan (PRYSMIAN, 2016). Temperature measurements for an internal AC current cable system at the Danish "Nysted" offshore wind farm showed sediment warming of max. 1.4 K directly above the cable (transmission capacity 166 MW) 20 cm below the seabed (MEISSNER et al. 2007). Moreover, intensive water movement close to the seabed in the North Sea leads to rapid dissipation of local heat.

Taking into account the above results and forecasts, it can be assumed that compliance with what is known as the "2 K criterion"[35] – which has established itself as a precautionary value in current regulatory approval practice – can be assumed at a laying depth of at least 1.50 m. A corresponding sediment warming principle has already been included in the Spatial Offshore Grid Plan for the North Sea and continued in the Site Development Plan in order to ensure compliance with the "2 K criterion", i.e. a maximum temperature increase of 2 degrees at a depth of 20 cm below the seabed surface (see e.g. planning principles 5.3.2.9, 5.4.2.9, 5.5.2.13 in the Spatial Offshore Grid Plan for the North Sea and planning principle 4.4.4.8).

This principle specifies compliance with the 2 K criterion in order to minimise potential adverse impacts on the marine environment due to cable-induced sediment warming. If there is compliance with the 2 K criterion in accordance with the planning principle, it can be assumed at present that no significant effects, such as structural and functional changes, are to be expected from cable-induced sediment warming of soil as a protected asset. No significant release of pollutants is likely to occur as a result of sediment warming due to the low amount of organic material in the sediment.

4.2 Benthos

The construction of platforms and wind turbines, as well as the installations themselves, may impact on the macrozoobenthos.

The North Sea EEZ is not of outstanding importance with regard to the species inventory of benthic organisms. Moreover, the benthic communities identified have no special features as they are typical for the German North Sea due to the predominant sediments. Studies of macrozoobenthos within the framework of the approval procedures for offshore wind farms and from AWI projects from 1997 to 2014 have revealed typical communities or transitional communities in the North Sea EEZ. The species inventory found previously and the number of Red List species indicate that the study area for benthic organisms is of predominantly average importance, or above average in some areas.

4.2.1 Areas and sites

Due to construction: The deep foundation work for wind turbines will result in disturbances of the seabed, sediment agitation and formation of turbidity plumes. This may result in impairment of or damage to benthic organisms or communities in the immediate vicinity of the installations while construction activities are in progress.

The resuspension of sediment in particular will lead to direct impairments of the benthic community during construction of the installations. Turbidity plumes are to be

[35] "What is known as the 2 K criterion represents a precautionary value which, in the BfN's estimation, ensures with reasonable certainty, on the basis of available information, that considerable adverse impacts of cable heating on nature or the benthic community are prevented"

expected during the foundation work for the installations. However, the concentration of the suspended material normally decreases very rapidly further away.

The resuspension of sediment in particular will lead to direct impairments of the benthic community during construction of the installations. Turbidity plumes are to be expected during the foundation work for the installations. However, the concentration of the suspended material normally decreases very rapidly further away. The dispersion of sediment particles is largely dependent on the fine particle levels and the hydrographic situation, particularly waves and current (HERMANN & KRAUSE 2000).

The released sediment will settle quickly due to the predominant sediment composition. After small-scale drifting, the sand portion will be deposited again and may lead to impairments of the macrozoobenthos by covering them. Many soft soil types are relatively insensitive to overburden and can survive several centimetres of additional sedimentary deposition (BIJKERK 1988). According to ESSINK (1996), overlaying with sandy sediments is tolerated better than overlaying with muddy sediments. Thus polychaetes such as *Nereis* spp. and *Nephtys* spp can overcome a layer of mud up to 60 cm thick and a layer of fine sand up to 85 cm thick. Surveys of *Tellina* spp. revealed a lethal layer thickness of 38 cm when covered with mud and a layer thickness of 45 cm when covered with fine sand (ESSINK 1996). It can also be assumed that there will only be very small deposits and that the macrozoobenthos will be able to compensate for this rather minor cover. According to available information, the effects of turbidity plumes and sedimentation due to the nature of construction can be classified as short-term and small-scale.

<u>Due to the installation</u>, the sealing of surfaces, the introduction of hard substrates and changes in the current conditions around the installations may lead to changes in the benthic community. Sealing of the surface and land use will occur in the vicinity of the installations and the associated scour protection, resulting in complete loss of macrozoobenthos habitats in the soft soil.

Besides habitat losses and habitat changes, new non-native hard substrate habitats will emerge. This will allow the soft soil fauna in the immediate vicinity to be influenced. According to KNUST et al. (2003), the introduction of artificial hard substrates into sandy soils will lead to colonisation by additional species. Recruitment of these species will most likely be from natural hard substrate habitats such as superficial till and rock deposits: hence there is low risk of adverse influence on the benthic sandy soil community from atypical species.

Studies on the FINO1 research platform have shown that the benthic community up to a distance of 17 metres was influenced in the immediate vicinity of the structures. A change from formerly sedentary and sessile species to mobile species was observed, caused by sediment erosion and an increase in predators (JOSCHKO 2007). Surveys of various wind turbine foundation structures have shown that the hard substrate of the installations leads to the accumulation and reproduction of mobile megafauna species such as the edible crab (*Cancer pagurus*). This was particularly pronounced in installations with scour protection (KRONE et al. 2017).

According to available information, <u>operational</u> effects of the wind turbines on the macrozoobenthos are not to be expected.

Given the above statements and representations, the result of the SEA is that according to available information, no significant effects on benthos as a protected asset are to be expected from the specification of the territories and areas in the Site Development Plan. Overall, the effects on benthos as a protected asset are deemed to be short-term and small-scale. Only small-scale areas outside conservation areas will be used, and rapid repopulation is very likely because the populations of benthic organisms with short generation cycles and their widespread distribution in the German Bight are usually capable of rapid regeneration.

The impact forecasts described in chapter 4.2.3 apply correspondingly with regard to the construction, installation-related and operational effects of cabling within the wind farms.

4.2.2 Platforms

Due to construction: The deep foundation work for platforms will result in disturbances of the seabed, sediment agitation and formation of turbidity plumes. This may result in impairment of or damage to benthic organisms or communities in the immediate vicinity of the platforms to be erected while construction activities are in progress.

The effects of seabed disturbance, formation of turbidity plumes and sedimentation as described in chapter 4.2.1apply similarly to the construction of platforms. Overall, construction-related effects can be classified as short-term and small-scale.

Due to the installation, the sealing of local surfaces, the introduction of hard substrate and changes in the current conditions around the platforms may lead to changes in the benthic community. Besides habitat losses and habitat changes, new non-native hard substrate habitats will emerge. This will allow the soft soil fauna in the immediate vicinity to be influenced. The installation-related effects described in chapter 4.2.1 also apply similarly to the platforms. Although the effects are long-term, they are limited to the immediate vicinity of the platforms on a small scale.

Due to operation, the removal of cooling water and the introduction of heated water may result in damage to the eggs and larval stages of macrozoobenthos. Up to 200 litres of sea water per second are extracted at a depth of 10-15 m in order to cool the units; the eggs and larval stages of various macrozoobenthos species are also sucked in and damaged or killed by the subsequent transit and heating. However, the amount of water removed is very small in relation to the size of the water body in which the eggs and larvae are distributed, so relevant effects on the population level are not to be expected at present.

The sea water required to cool the units is released back into the environment at a maximum temperature of 35 °C. This leads to local warming. In principle, increases in water temperature will lead to changes in the faunal communities, or to lethal damage to eggs and larvae at very high temperatures. However, the amount of cooling water returned is very small in relation to the size of the water body in which the eggs and larvae are distributed. Furthermore, the tidal flow is expected to lead to rapid mixing, so relevant effects on eggs and larvae of macrozoobenthos are not to be feared.

Given the above statements and representations, the result of the SEA is that according to available information, no significant effects on benthos as a protected asset are to be expected from the specification of the platform locations in the Site Development Plan.

Overall, the effects on benthos as a protected asset are deemed to be short-term and small-scale. Only very small-scale areas outside conservation areas will be used, and rapid repopulation is very likely because the populations of benthic organisms with short generation cycles and their widespread distribution in the German Bight are usually capable of rapid regeneration.

4.2.3 Submarine cabling systems

Due to construction: Possible effects on benthic organisms are dependent on the laying methods used. Only small-scale, short-term and thus minor disturbances of the benthos in the vicinity of the cable route are to be expected due to careful laying of the submarine cable systems using the induction method. Local sediment agitation and turbidity plumes are to be expected during the laying of the submarine cable systems. This may result in small-scale and short-term habitat loss for benthic species or impairment of or damage to benthic organisms or communities in the vicinity of the cable systems while construction activities are in progress. Burial of sessile benthic organisms such as molluscs and polychaetes is the main risk from sedimentation of the released sediment (ICES 1992).

In the event of a decline in population due to natural or anthropogenic disturbance (e.g. cable jetting), there remains sufficient potential in the overall system for organisms to repopulate (KNUST et al. 2003). According to BOSSELMANN (1989), dispersion occurs not only through the larval stages, but also through the dispersion of postlarval and adult forms. Furthermore, accompanying surveys of the benthos and fish and decapod fauna (crabs) in the case of the Europipe pipeline laid in 1994 showed that just two years after completion of the construction work, the communities were already showing a clear return to the condition they were in prior to the construction work. It was assumed there that it would no longer be possible to identify the effects of the construction work two to three years after the construction activities (KNUST et al. 2003). The linear nature of the submarine cable systems favours repopulation from the undisturbed peripheral areas.

Turbidity plumes are caused by disturbance of the sediment during cable system jetting. The dispersion of sediment particles is largely dependent on the fine particle levels and the hydrographic situation (particularly waves and current) (HERRMANN & KRAUSE 2000). The predominant sediment composition in the North Sea EEZ means that most of the sediment released will settle directly at the construction site or in its immediate vicinity.

According to available information, therefore, the impairments during the construction phase will remain small-scale and generally short-term. Short-term occurrence of elevated concentrations of suspended matter does not appear to be harmful to adult molluscs. Growth of filter-feeding molluscs may even be promoted. However, eggs and larvae of a species generally react more sensitively than adult animals and could be damaged by turbidity plumes on a short-term and small scale. Although the concentration of suspended particles may reach values that are harmful to certain organisms, the effects on macrozoobenthos are to be regarded as relatively small since such concentrations occur only spatially and temporally and are rapidly degraded again by dilution and distribution effects (HERRMANN and KRAUSE 2000).

Moreover, benthic organisms may be affected on a short-term, small-scale basis by the release of nutrients and pollutants associated with the resuspension of sediment particles. The oxygen content may decrease if organic substances are dissolved (HERRMANN and KRAUSE 2000).

The effects are generally considered to be minor, since the jetting of the cable systems is limited temporally and spatially and the pollutant load in the EEZ territory is comparatively low. In addition, waves and currents rapidly dilute any increases that may occur in the concentration of nutrients and pollutants.

Potential effects that may result from repair work that may become necessary are comparable to the possible effects due to construction. As the damaged cable section can be located quite precisely as described, the effects are likely to be limited directly to the cable section in question.

Due to the installation: The disruption in the vicinity of possible cable crossings will be permanent, but also small-scale. Required cable crossings will be secured with rockfill, which is a permanent, non-native hard substrate. The non-native hard substrate will provide a new habitat for benthic organisms. This will make it possible for species and communities to settle even in areas where they were not found previously, allowing them to extend their distribution ranges (SCHOMERUS et al. 2006).

Due to operation, warming of even the uppermost seabed sediment layer may occur directly above the cable system, which may reduce winter mortality of the infauna and lead to a change in the species communities in the vicinity of the cable routes. In particular, species that thrive in cold water (e.g. *Arctica islandica*) may be displaced from the vicinity of the cable routes. According to available information, no significant effects on the benthos due to cable-induced sediment warming are to be expected if a sufficient laying depth is maintained and if cable configurations are used according to the state of the art. Various calculations relating to sediment warming due to the operation of submarine cables were presented as part of the environmental contributions for current-carrying cable systems of offshore wind farms. According to the applicant, the cable-induced sediment warming in the "BorWin 3 and BorWin gamma" project will amount to approximately 1.3 K at a sediment depth of 20 cm for the DC Subsea Cables if the cables are jetted to a depth of at least 1.50 m as specified in the Site Development Plan (PRYSMIAN, 2016). Moreover, intensive water movement close to the seabed in the North Sea leads to rapid dissipation of local heat.

Taking into account the above results and forecasts, compliance with what is known as the "2 K criterion" can be assumed at a laying depth of at least 1.50 m. In order to ensure compliance with the "2 K criterion", a sediment warming principle was included in the Site Development Plan (planning principle 4.4.4.9). This principle specifies compliance with the 2 K criterion in order to minimise potential adverse impacts on the marine environment due to cable-induced sediment warming. If there is compliance with the 2 K criterion in accordance with the planning principle, no significant effects on benthic communities from cable-induced sediment warming are to be expected at present.

The same assumptions apply to electric or electromagnetic fields. Likewise, these are not expected to have any significant effects on macrozoobenthos. If state-of-the-art DC Subsea Cables are used, an electric field will only occur within the cable in question, i.e. only between the conductor and the earthed shielding. Therefore, there will be no external electric field. Even with AC Subsea cables, electric fields outside the cable system can be avoided by means of suitable insulation or appropriate cable configuration, so that electric fields do not occur in a significantly measurable way.

The magnetic fields of the individual cables generated during operation are largely cancelled out in both the DC submarine cable systems, which consist of an outbound conductor and a return conductor with opposite current flow directions, and the AC submarine cable systems, and are significantly below the strength of the Earth's natural magnetic field. Modelling for DC submarine cable systems showed values from 11 to max. 15 µT at the surface of the seabed (PGU 2012a, PGU 2012b). In comparison, the Earth's natural magnetic field is 30 to 60 µT, depending on its location. Due to the lower load current and the three-wire technology, a weaker magnetic field can be assumed for AC Subsea cable systems than for DC Subsea Cable systems. Values of less than 10 µT are to be expected for AC Subsea Cable systems (see PGU 2013). The strongest fields occur directly above the cable systems. Further away, the strength of the fields decreases relatively quickly. As long as the cables are laid at sufficient depth, and taking into account the fact that the effects will occur on a small scale, i.e. just a few metres on either side of the cable, no significant effects on the benthic communities are expected from the laying and operation of the submarine cable systems according to available information. According to available information, the ecological effects will be small-scale and largely short-term.

4.3 Biotopes

As in the case of the Spatial Offshore Grid Plan and in consultation with the BfN, in contrast to the impact assessment in Section 34 of the Federal Nature Conservation Act, no cumulation of impairments caused by various actions will be required for determination, description and assessment of the likely significant environmental effects by due to the specifications of the Site Development Plan with regard to legally protected biotope types pursuant to section 30 subsection 2 no. 6 of the Federal Nature Conservation Act that do not coincide with the habitat type. In this respect, there will be no cumulative consideration of the interaction of individual specifications with one another or with existing projects.

4.3.1 Areas and sites

Possible effects of territories and areas on biotopes as a protected asset may result from direct use of protected biotopes, possible covering by sedimentation of material released during construction and potential habitat changes.

Considerable use of protected biotopes by the installations <u>due to construction</u> is not to be expected, as protected biotope structures according to section 30 of the Federal Nature Conservation Act are to be avoided as far as possible within the framework of the specific approval procedure. Given the predominant sediment composition in areas in which protected biotopes can be expected to occur, impairments due to sedimentation are likely to be small-scale as the released sediment will settle quickly. Given the predominant low currents close to the seabed, turbidity plumes can only be expected in areas with soft sediments up to a distance of approx. 500 m which clearly exceed natural suspended matter maxima. The released material remains in the water column for long enough to be distributed over a large area, so barely detectable thicknesses of the deposited material are to be expected due to the comparatively small volumes. Simulations show that the sediment released will have resettled after a maximum of 12 hours. Thus, according to available information, the impairments will generally remain small-scale and temporary.

<u>Due to the installation</u>, permanent habitat changes will occur; although these will be limited to the immediate vicinity of the installations. The artificial hard substrate will provide benthic organisms with a new habitat and may lead to a change in species composition (SCHOMERUS et al. 2006). Significant effects on biotopes as a protected asset are not to be expected on account of these small-scale areas. In addition, the recruitment of species will most likely take place from the natural hard substrate habitats, such as superficial till and rocks. Thus there is little risk of atypical species having a negative influence on the soft-bottom benthic community.

According to available information, <u>operational</u> effects of the wind turbines on biotopes are not to be expected.

4.3.2 Platforms

Possible effects of platforms on biotopes as a protected asset may result from direct use of protected biotopes due to the foundations of the platforms, possible covering by sedimentation of material released during construction and potential habitat changes.

The construction-related and installation-related effects on biotopes through direct use, sedimentation and habitat change as described in chapter 4.3.1 also apply similarly to the construction of platforms. Overall, construction-related and installation-related effects can be classified as short-term and small-scale. According to available information, operational effects on biotopes due to the platforms are not to be expected.

4.3.3 Submarine cabling systems

Potential construction-related effects of submarine cables on biotopes as a protected asset may result from direct use of protected biotopes, possible covering by sedimentation of released material and potential habitat changes. Direct use of protected biotopes will be avoided as far as possible through the planning of submarine cable systems. Furthermore, protected biotopes according to section 30 of the Federal Nature Conservation Act are to be treated as being of special importance within the framework of the specific approval procedure and avoided as far as possible within the framework of fine routing (see planning principle 4.4.4.9).

Given the predominant sediment composition, impairments due to coverage are likely to be small-scale as the released sediment will settle quickly.

Installation-related, permanent habitat changes will be limited to the immediate vicinity of rockfills which will be necessary in the case of cable crossings. The rockfills permanently represent a non-native hard substrate, even in areas with predominantly homogeneous sandy seabed. The non-native hard substrate will provide benthic organisms with a new habitat and may lead to a change in species composition (SCHOMERUS et al. 2006). These small-scale habitat changes due to submarine cable systems and, in particular, cable crossing structures are not expected to have a significant impact on biotopes as a protected asset. The Site Development Plan establishes a planning principle to minimise cable crossings (planning principle 4.4.4.5). In addition, the recruitment of species will most likely take place from the natural hard substrate habitats, such as superficial till and rocks. Thus there is little risk of atypical species having a negative influence on the sandy bottom benthic community.

According to planning principle 4.4.4.9, known occurrences of protected biotopes should be avoided as far as possible in accordance with section 30 of the Federal Nature Conservation Act. A survey of whether the marine biotopes taken into account in section 30 of the Federal Nature Conservation Act subsection 1 no. 6 actually occur at the site of the planned submarine cable routes and may possibly be impaired cannot be performed due to the lack of reliable data at the level of this SEA, since there has been no detailed site-wide biotope mapping for the North Sea EEZ to date. This survey has to be carried out within the scope of the site investigation, as well as environmental surveys in the specific approval procedure for the planned submarine cable systems. Particular emphasis must be placed on proven occurrences when taking them into account in the individual approval procedure.

In principle, it is assumed that biotopes, in particular reefs, protected pursuant to section 30 of the Federal Nature Conservation Act, which have a specific sensitivity to cable laying, occur only selectively and on a small scale and can be avoided within the framework of fine routing. If it is not possible to avoid these strictly protected biotopes or habitat types, e.g. because the occurrences are more extensive, considerable impairment of these legally protected biotopes cannot be ruled out. The specific individual procedure must check, on the basis of available data from the route surveys, whether the affected area is so large that there will be considerable impairment.

4.4 Fish

The species composition for fish fauna in the area is typical. In all regions, the demersal fish community is dominated by flatfish, as is typical for the German Bight.

4.4.1 Areas and sites

According to current knowledge, the planned locations are not a preferred habitat for any of the protected fish species. Consequently, the fish population in the planning area is of no prominent ecological importance.

The construction and operational effects of the wind farms on fish fauna will be limited spatially and temporally. Construction activities will lead to sediment agitation and turbidity plumes, which – although limited in terms of time and specific to species – may cause physiological impairments and deterrence. Predators such as Atlantic mackerel and Atlantic horse mackerel that hunt in open waters avoid areas with high sediment loads, thereby avoiding the risk of the gills sticking together (EHRICH & STRANSKY 1999). Therefore, a threat to these species as a result of sediment agitation does not appear likely due to their high levels of mobility. Moreover, impairment of demersal fish is not to be expected due to their good swimming characteristics and associated evasion options. In the case of European plaice and common sole, increased foraging activity was even observed following storm-induced sediment agitation (EHRICH et al. 1998). In principle, however, fish can avoid disturbances due to their pronounced sensory abilities (lateral line) and their high levels of mobility, so impairments for adult fish are unlikely. Eggs and larvae which are not yet or only slightly susceptible to reception, processing and conversion of sensory stimuli are generally more sensitive than adult conspecifics. However, the spawning grounds of most fish species are located outside the wind farm sites to be developed in the German EEZ. After fertilisation, fish eggs form what is known as the outer shell, which makes them resistant to mechanical stimuli such as agitated sediments. The early life stages may possibly also be adapted to turbulence, which recurs regularly as a result of natural phenomena such as storms or currents.

It is likely that periods of short, intensive sound exposure – especially during the installation of the foundations – will lead to the deterrence of fish during the construction phase. Almost all fish can perceive the acoustic intensity and frequency spectrum generated during pile driving (KNUST et al. 2003)

However, the range of perception and possible species-specific behavioural reactions have only been studied to a limited extent to date. The sound pressure produced during pile driving was sufficient to cause internal bleeding and barotrauma of the swim bladder in cod (*Gadus morhua*). This effect was observed from a distance of 1400 m or closer to a source of noise from pile driving (DE BACKER et al..2017). However, a flight reaction among fish can also be expected here, and a return when the disturbance has ended is likely.

Construction measures in the "alpha ventus" test field resulted in a greatly reduced population of pelagic fish relative to the surrounding area (AWI 2014); and there were clear indications of temporary deterrence in the "BARD Offshore 1" project area as well during the three-year construction phase,

presumably due to pile driving and increased shipping traffic. The fish returned quickly to the areas avoided previously after completion of pile driving.

Hydroacoustic surveys at the first German wind farm "alpha ventus" showed a reduced fish density during the construction phase, probably due to pile driving and other construction activities. Neither deterrence nor attraction could be proven during subsequent operation (KRÄGEFSKY 2014). This finding was confirmed for the "BARD Offshore 1" and "Global Tech 1" wind farms for Atlantic herring (*Clupea harengus*) and European sprat (Sprattus sprattus) (FLOETER et al. 2017). An increased density of individuals near the turbine foundations (SCHRÖDER et al. 2013, KRÄGEFSKY

2014) suggests a trophic relationship between pelagic fish and vegetation, but hard substrate-associated organisms for Atlantic mackerel (*Scomber scombrus*) and Atlantic horse mackerel (*Trachurus trachurus*) are only insignificant food components (KRÄGEFSKY 2014). The filter-feeding species that make up most of the vegetation at the foundations could influence plankton density, which is also crucial for plankton-eating fish. However, this could not be measured by means of the abundance of pelagic fish. Instead, significantly increased meroplankton densities were observed in water bodies that had previously flowed through a wind farm (FLOETER et al. 2017). As fishing at the wind farms will largely be excluded, the installation of wind farms will create retreat areas from which the surrounding areas could also receive fish.

4.4.2 Platforms

The species composition for fish fauna in the vicinity of the planned converter sites is typical. In all regions, the demersal fish community is dominated by flatfish, as is typical for the German Bight. According to available information, the planned converter sites are not a preferred habitat for any of the protected fish species. As a result, the fish population in the vicinity of the planned converter platforms is of no prominent ecological importance. The construction, installation-related and operational effects of the converter platforms on fish fauna will be limited spatially and temporally. Due to construction: Construction activities will lead to sediment agitation and turbidity plumes, which – although limited in terms of time and specific to species – may cause physiological impairments and deterrence. According to EHRICH & STRANSKY (1999), predators such as Atlantic mackerel and Atlantic horse mackerel that hunt in open waters avoid areas with high sediment loads, thereby avoiding the risk of the gills sticking together and restricting their respiration. Therefore, a threat to these species as a result of sediment agitation does not appear likely due to their evasion capabilities. Impairment of demersal flatfish such as European plaice and common sole is not to be expected. According to EHRICH et al. (1998), these two fish species - for example - even show increased foraging activity during storm-induced sediment agitation. Overall, therefore, low levels of impairment can be assumed for adult fish. The released sediment will also settle quickly due to the predominant sediment composition. Thus, according to available information, the impairments will generally remain small-scale and temporary. A short-term increase in the concentration of sediment particles does not appear to be harmful for adult fish, as it is known that fish avoid areas with high levels of anthropogenic sediment agitation (IFAF, 2004). However, eggs and larvae of a species generally react more sensitively than adult animals, so turbidity plumes may cause short-term and small-scale damage to fish eggs and larvae. For most fish species occurring in the EEZ, however, spawn damage is not to be expected as the potential impairment of fish spawn is dependent on the reproduction strategy. The eggs of pelagic spawning fish usually have a protective layer that protects them from mechanical effects caused by agitated sediments. Moreover, the fish fauna is adapted to the natural sediment agitation that is typical here, caused by storms. Although the concentration of suspended particles can reach levels that are harmful to certain organisms, the effects on fish can be regarded as relatively small, as such concentrations are limited both spatially and temporally (HERMANN & KRAUSE 2000). This also applies to potential increases in the concentration of nutrients and pollutants due to the resuspension of sediment particles, which are rapidly degraded again by dilution and distribution effects (ICES 1992, 1998). Construction activities will lead to noise emissions that may deter fish. It is likely that periods of short, intensive sound exposure – especially during the installation of the foundations – will lead to deterrence during the construction phase. However, it is to be expected that the fish will return to the area after the source of the noise has disappeared. With corresponding intensity, physiological damage to the hearing or other organs, with lethal consequences, is also conceivable. This applies in particular to noise emissions during pile driving (WOODS et al. 2001). KNUST et al. (2003) assume that almost all fish species will be capable of perceiving noise emissions from pile driving due to the high acoustic intensity and the sound spectrum produced. However, the range of perception and possible species-specific behavioural reactions have not been studied to a sufficient extent to date. The survey of the construction-related effects of wind turbines on fish in the "alpha ventus" test field (AWI 2014) indicated the deterrent effect of construction measures due to the strongly reduced population of pelagic fish in the "alpha ventus" region during the construction phase compared with the surrounding area. In the "BARD Offshore 1" project area, too, there were clear indications of temporary deterrence during the three-year construction phase, which were presumably mainly noise-induced. The small-scale results show deterrence and thus impairment of fish fauna for the areas affected by noise emissions in the construction area before (intensification of shipping traffic) and during pile driving. The results also confirm, however, that the respective areas will be quickly accessed by fish fauna again after completion of pile driving. No further significant effects were apparent in the fish communities five months after pile driving (PGU 2013). During construction of the converter platforms, noise emissions will be generated by the use of ships, cranes and construction platforms and the installation of the platform foundations. The risk to fish due to the impact of noise from pile driving is likely to be reduced by measures arranged for noise reduction purposes. Partial aspects of the deterrence measures for marine mammals are probably applicable to fish as well. In accordance with the planning principle for noise reduction during pile driving, the noise control limit is an emitted sound exposure level of less than 160 dB re 1μPa²s outside a circle with a radius of 750 m around the pile driving or installation site.

Due to the installation: The construction of the foundations of the converter platforms and the scour protection will build over local habitats. Demersal fish will lose habitats permanently as a result, but on a very small scale. An increase in the local biomass is predicted in all known studies to date due to the assumed colonisation of the foundation surfaces by benthic and algae species, which may lead to expansion of the food spectrum and food availability for individual species, as well as an increase in species diversity. While individual studies show attraction for demersal fish, these have not yet been demonstrated for the highly mobile pelagic species.

Due to operation: The converter platforms do not pose any significant risk to fish during operation. The removal of cooling water and the discharge of heated water may lead to impairment of fish larvae during operation of the converter platform, but relevant effects on the ichthyoplankton or the fish community are not to be expected as the amount of water removed and heated is very small in relation to the size of the water body in which it is distributed. In summary, it can be stated that given available information and taking into account the assessment of the situation, it is unlikely that the planned converter sites will significantly impair fish as a protected asset. The effects of construction on fish fauna are not considered to be significant overall, as they are small-scale and short-term in nature. Noise emissions from the construction phase are to be reduced by means of suitable measures. The specific design of these measures is to be dealt with by the individual approval procedure. No significant effects are to be expected with regard to possible operational effects of the converter platforms, either.

4.4.3 Submarine cabling systems

The species composition for fish fauna on the intended submarine cable routes is typical. In all regions, the demersal fish community is dominated by flatfish, as is typical for the German Bight. Consequently, fish populations in the region of the submarine cable routes are of no overriding ecological importance compared to adjacent marine areas. The construction, installation-related and operational effects of the submarine cable systems on fish fauna will be limited spatially and temporally.

Due to construction: When laying the cable systems, turbidity plumes may occur temporarily and local sediment agitation may occur. This may result in impairment of or damage to fish in the vicinity of the cable systems while construction activities are in progress. The released sediment will settle quickly due to the predominant sediment composition. Thus the impairments remain small-scale. Fish may also be deterred temporarily, resulting in small-scale and short-term habitat loss due to construction-related noise and vibrations. A short-term increase in the concentration of sediment particles does not appear to be harmful for adult fish, as it is known that fish avoid areas with high levels of anthropogenic sediment agitation (IFAF 2004). These include predators that hunt in open waters, such as Atlantic mackerel and horse mackerel, which avoid areas with high sediment loads, thereby avoiding the risk of the gills sticking together and restricting their respiration (EHRICH & STRANSKY 1999). However, eggs and larvae of a species generally react more sensitively than adult animals, so turbidity plumes may cause short-term and small-scale damage to fish eggs and larvae. For most fish species occurring in the EEZ, however, spawn damage is not to be expected as the potential impairment of fish spawn is dependent on the reproduction strategy. The eggs of pelagic spawning fish usually have a protective layer that protects them from mechanical effects caused by agitated sediments. Although the concentration of suspended particles may reach values that are harmful to certain organisms, the effects on fish are to be regarded as relatively small since such concentrations occur only spatially and temporally and are rapidly degraded again by dilution and distribution effects (HERRMANN & KRAUSE 2000). This also applies to potential increases in the concentration of nutrients and pollutants due to the resuspension of sediment particles (ICES 1992, ICES WGEXT 1998). The primary risk during sedimentation of the released substrate is that fish spawn deposited on the seabed may be covered. This may result in an insufficient supply of oxygen to the eggs and potentially leading to damage to or even death of the spawn, depending on efficiency and duration.

For most fish species occurring in the EEZ, spawn damage is not to be expected as they either have pelagic eggs and/or their spawning sites are in shallow waters outside the EEZ. Moreover, the fish fauna is adapted to the natural sediment agitation that is typical here, caused by storms.

Due to operation: Generation of magnetic fields cannot be ruled out when submarine cables are operated. Direct electric fields do not occur in a significantly measurable way in either DC or AC submarine cable systems. The magnetic fields of the individual cable systems will be largely eliminated in the planned bipolar (outbound and return conductors) or three-wire cable configurations. Modelling for DC submarine cable systems resulted in values from 11 to max. 15 µT at the surface of the seabed (PGU 2012a, PGU 2012b). In comparison, the Earth's natural magnetic field is 30 to 60 µT, depending on its location. Due to the lower load current and the three-wire technology, a weaker magnetic field can be assumed for AC Subsea Cable systems than for DC Subsea Cable systems. Values of less than 10 µT are to be expected for AC Subsea Cable systems. The strongest magnetic fields occur directly above the cable system. Further away from the cable system, the strength of the fields decreases relatively quickly. Orientation to the Earth's magnetic field is documented for a number of fish species, in particular migratory species such as Atlantic salmon and European eel. These species can perceive electric fields, which in some cases may lead to behavioural changes (MARHOLD & KULLINK 2000, ÖHMANN 2007). According to KULLINK & MARHOLD (1999), potential impairment of the orientation behaviour of adult individuals of species that use electric or magnetic fields for orientation (such as eels, sharks and salmon) is at most short-term, as experiments on the Baltic Sea eels have shown. Fish rely on different environmental parameters which are responsible for orientation in interaction.

In summary, it can be stated for the SEA that according to available information, no significant impairment of fish as a protected asset is to be expected from the laying and operation of submarine cables. The overall impact of construction on fish fauna is not considered to be significant. As far as possible operational effects of the submarine cable systems are concerned, such as magnetic fields and the temperature increase of the sediment, no significant effects are to be expected either.

4.5 Marine mammals

4.5.1 Areas and sites

According to the latest information available, it can be assumed that the German EEZ is used by harbour porpoises for crossing and resting, and also as a feeding ground and – in specific locations – as a nursery area. Given the available information, in particular from current surveys for offshore wind farms and the monitoring of the Natura 2000 areas, medium to high regional importance of the study site for harbour porpoises can be inferred. The use varies in the territories of the plan in the EEZ. This also applies to harbour seals and grey seals. Areas N-1, N-2 and N-3 are of medium to high importance for harbour porpoises – seasonal in spring – and of minor to medium importance for grey seals and harbour seals. Area N-4 is located in the identified main concentration area for harbour porpoise in the German Bight during the summer months and is therefore of great importance. Area N-4 is of medium importance for harbour seals and grey seals. The territories of area N-5 are located in an area which is used by harbour porpoises as a feeding ground and nursery area – although the concentration is focused on the FFH area "Sylt Outer Reef" (BMU 2013). In general, area N-5 is considered to be of high importance for harbour porpoises. The high importance of area N-5 is associated with the special function of the area as a nursery area. Area N-5 is of medium importance for harbour seals and grey seals. Areas N-6 to N-11 are of medium importance for harbour porpoises. However, area N-13 and parts of area N-11 are used intensively by harbour porpoises as feeding grounds in summer. These belong to the large contiguous main concentration area of the harbour porpoise in the German Bight and are therefore of great importance for harbour porpoises during the summer months. Areas N-6 to N-13 are of little importance for harbour seals and grey seals.

<u>Due to construction:</u>

Harbour porpoises, grey seals and harbour seals may be put at risk by noise emissions during the construction of offshore wind turbines, transformer stations and converter platforms unless avoidance and mitigation measures are implemented. Impulse noise or continuous noise can be registered, depending on the method used for the foundation work. The creation of impulse noise when driving piles using hydraulic hammers has been investigated thoroughly. Available information on impulse noise is contributing significantly to the development of technical noise reduction systems. That said, very little is known about the creation of continuous noise as a result of foundation pile installation using alternative methods. Potential effects on the marine environment cannot be estimated due to a lack of knowledge about continuous noise. This is the case with the use of pile driving air hammers, for example, but also with what are known as suction buckets. Only gravity foundations that can be installed without protective walls can be described as low-noise. However, other effects of gravity foundations, such as the sealing of large areas and the associated change in the functions of the seabed in respect of environmental compatibility, also need to be considered.

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

The noise control limit recommended by the UBA has already been devised by means of preparatory work in various projects (UNIVERSITY OF HANOVER, ITAP, Research and Technology Centre 2003). For precautionary reasons, "margins of safety" were taken into account, e.g. for the previously documented interindividual distribution of hearing sensitivity, and above all because of the problem of repeated exposure to loud noise impulses as will occur during pile driving of foundations (ELMER et al., 2007). At present, only very limited reliable data is available for the purposes of evaluating the duration of exposure to noise from pile driving. However, pile driving that may take several hours has much higher potential for harm than the driving of a single pile. The margin of the above limit value at which a sequence of individual events is to be assessed remains unclear at present. A margin of 3 dB to 5 dB for each tenfold increase in the number of pile driving pulses is being discussed in expert circles. The limit used in approval practice is below the limit proposed by SOUTHALL et al. (2007), due to the uncertainties shown here in the evaluation of the exposure time.

Within the framework of the establishment of a measurement regulation for the recording and evaluation of underwater noise from offshore wind farms, the BSH has concretised, and as far as possible standardised the specifications from the UBA recommendation (UBA 2011), as well as from the findings of the research projects with regard to noise control limits. In the measurement regulation for the BSH's underwater noise measurements, the evaluation level is defined as the SEL_5 value: i.e. 95% of the measured single sound exposure levels must be below the statistically determined SEL_5 value (BSH 2011). The extensive efficiency control measurements show that the SEL_5 is up to 3 dB higher than the SEL_{50}. Thus the definition of the SEL_5 value as an evaluation level led to further tightening of the noise control limit so as to take the precautionary principle into account.

In its overall assessment of the available technical information, the BSH therefore assumes that the sound exposure level (SEL_5) outside a circle with a radius of 750 m around the pile driving or installation site must not exceed 160 dB (re 1 µPa) so as to be able to exclude impairment of harbour porpoises with the necessary certainty.

The first results on the acoustic resilience of harbour porpoises were obtained within the framework of the MINOSplus project. Following exposure to noise with a maximum receiving level of 200 pk-pk dB re 1 µPa and an energy flux density of 164 dB re 1 µPa2/Hz, a temporary threshold shift (known as a TTS) was detected for the first time at 4 kHz in an animal in captivity. It also showed that the threshold shift lasted more than 24 hours. Behavioural changes were registered in the animal from a receiving level of 174 pk-pk dB re 1 µPa (LUCKE et al. 2009). Besides the absolute volume, the duration of the signal also determines the effects on the exposure limit. The exposure limit decreases as the duration of the signal increases, i.e. permanent exposure may result in damage to animals' hearing even at lower volumes. On the basis of these latest findings, it is clear that harbour porpoises are subject to a threshold shift above 200 decibels (dB) at most, which may also result in damage to vital sensory organs.

The scientific evidence that has led to the recommendation or establishment of what is known as noise control limits is based mainly on observations in other cetacean species (SOUTHALL et al. 2007), or on experiments on harbour porpoises in captivity using what are known as airguns or air pulsers (LUCKE et al. 2009).

Without the use of noise reduction measures, considerable impairments of marine mammals cannot be excluded during pile driving for foundations. Driving of piles for wind turbines, transformer stations and converter platforms will therefore only be permitted in the specific approval procedure if effective noise reduction measures are implemented. For this purpose, the plan includes a specification regarding the noise reduction principle. This means that pile driving for the platform foundations must only be carried out in compliance with strict noise reduction measures. Extensive noise reduction measures and monitoring measures are imposed in the specific approval procedure to ensure compliance with the applicable noise control limits (sound exposure level (SEL) of 160 dB re 1µPa and maximum peak level of 190 dB re 1µPa at a distance of 750 m from the pile driving or installation site). Appropriate measures must be implemented so as 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 reduction show that the use of suitable measures can significantly reduce or even completely prevent the effects of noise pollution on marine mammals. Taking into account available information, conditions are imposed in the specific approval procedure with the aim of avoiding the effects of noise pollution on harbour porpoises as far as possible. The extent of the obligations required at licensing level is determined by the specific assessment of the project at site and project level on the basis of wildlife conservation and territorial protection requirements. The BMU's noise abatement concept has also been in force since 2013. According to the noise abatement concept, pile driving must be coordinated in terms of time in such a way that sufficiently large areas, particularly within the conservation areas and the main concentration area for harbour porpoise in the summer months, are kept free of effects related to pile driving.

As a general rule, the considerations concerning noise pollution caused by the construction and operation of wind turbines and platforms, as set out for harbour porpoises, also apply to all other marine mammals present in the indirect vicinity of the structures.

During pile driving in particular, direct disturbances of marine mammals at individual level are to be expected locally around the pile driving site and for a limited time. The effective pile driving time (including deterrence) to be adhered to in each case is specified in the approval procedure for specific sites and installations. Within the framework of the enforcement procedure, the coordination of noise-intensive work with other construction projects is also reserved so as to prevent or reduce cumulative effects.

Given the function-dependent importance of the areas for harbour porpoises, taking into account the BMU's noise abatement concept (2013) for the prevention of disturbances, the regulations laid down in the plan and the requirements within the scope of individual approval procedures for the reduction of noise inputs, Table 8 assesses the effects of noise-intensive construction work on harbour porpoises. The exclusion effect of wind farms and converter platforms in conservation areas and the implementation of the requirements of the BMU's noise abatement concept reduce the risk to harbour porpoises at important feeding grounds and nursery areas.

Operational noise from wind turbines and converter platforms has no effect on highly mobile animals such as marine mammals, according to available information.

It is known from oil and gas platforms that the attraction of various fish species leads to enrichment of the food supply (Fabi et al., 2004; Lokkeborg et al., 2002). Recordings of harbour porpoise activity in the immediate vicinity of platforms has also shown an increase in harbour porpoise activity during the night, associated with foraging (TODD et al., 2009). It can therefore be assumed that the possible increase in food supply in the vicinity of converter platforms is highly likely to attract marine mammals.

As a result of the SEA, it can be stated that according to available information, no significant effects on marine mammals as a protected asset are to be expected from the construction and operation of offshore wind farms.

4.5.2 Platforms

According to the latest information available, it can be assumed that the German EEZ is used by harbour porpoises for crossing and resting, and also as a feeding ground and – in specific locations – as a nursery area. Given the available information, in particular from current surveys for offshore wind farms and the monitoring of the Natura 2000 areas, medium to high regional importance of the study site for harbour porpoises can be inferred. As already shown for the wind farm sites, the use varies in the territories of the EEZ. This also applies to harbour seals and grey seals.

Due to construction:

Harbour porpoises, grey seals and harbour seals may be put at risk by noise emissions during the construction of platforms unless avoidance and mitigation measures are implemented. The Federal Environment Agency (UBA) recommends compliance with noise control limits when constructing foundations for offshore wind turbines. The sound exposure level (SEL) should not exceed 160 dB (re 1 µPa) outside a circle with a radius of 750 m around the pile driving or installation site. The maximum peak sound pressure level should not exceed 190 dB. The UBA's recommendation does not include any further specifications of the SEL noise control limit (http://www.umweltdaten.de/publikationen/fpdf-l/4118.pdf, as at: May 2011).

Current technical developments in the field of underwater noise reduction show that the use of suitable measures can significantly reduce or even completely prevent the effects of noise pollution on marine mammals. Taking into account available information, conditions are imposed in the specific approval procedure with the aim of avoiding the effects of noise pollution on harbour porpoises as far as possible. The extent of the obligations required at licensing level is determined by the specific assessment of the project at site and project level on the basis of wildlife conservation and territorial protection requirements. The BMU's noise abatement concept has also been in force since 2013. According to the noise abatement concept, pile driving must be coordinated in terms of time in such a way that sufficiently large areas, particularly within the conservation areas and the main concentration area for harbour porpoise in the summer months, are kept free of effects related to pile driving.

As a general rule, the considerations concerning noise pollution caused by the construction and operation of converter platforms, as set out for harbour porpoises, also apply to all other marine mammals present in the indirect vicinity of the converter platforms.

During pile driving in particular, direct disturbances of marine mammals at individual level are to be expected locally around the pile driving site and for a limited time. Currently, the time required for pile driving is estimated to be one week, with an effective pile driving time of approximately three hours per pile. Therefore, a temporary loss of habitat around the converter platform is to be expected during pile driving for the foundations. The effective pile driving time (including deterrence) to be adhered to in each case is specified in the approval procedure for specific sites and installations. Within the framework of the enforcement procedure, the coordination of noise-intensive work with other construction projects is also reserved so as to prevent or reduce cumulative effects.

Given the function-dependent importance of the areas for harbour porpoises, taking into account the BMU's noise abatement concept (2013) for the prevention of disturbances, the principles in the Site Development Plan and the requirements within the scope of individual approval procedures for the reduction of noise inputs, Table 8 assesses the effects of platforms on harbour porpoises. The exclusion effect of platforms in conservation areas and the implementation of the requirements of the BMU's noise abatement concept reduce the risk to harbour porpoises at important feeding grounds and nursery areas.

Operational noise from platforms has no effect on highly mobile animals such as marine mammals, according to available information.

It is known from oil and gas platforms that the attraction of various fish species leads to enrichment of the food supply (Fabi et al., 2004; Lokkeborg et al., 2002). Recordings of harbour porpoise activity in the immediate vicinity of platforms has also shown an increase in harbour porpoise activity during the night, associated with foraging (Todd et al., 2009). It can therefore be assumed that the possible increase in food supply in the vicinity of converter platforms is highly likely to attract marine mammals.

As a result of the SEA, it can be stated that according to available information, no significant effects on marine mammals as a protected asset are to be expected from the construction and operation of converter platforms.

As a result of the SEA, it can be stated that according to available information, no significant effects on marine mammals as a protected asset are to be expected from the construction and operation of platforms.

4.5.3 Submarine cabling systems

Due to construction: During the installation phase, which is limited temporally and spatially, short-term deterrence may occur due to construction-related shipping traffic. However, these effects will not go beyond the disruptions generally associated with slow ship movements. Possible changes to the sediment structure and associated temporary changes in the benthos will have no significant impact on marine mammals, as they seek their prey in very extensive areas in the water column.

Operational sediment warming has no direct effect on highly mobile animals such as marine mammals. The influence of electromagnetic fields from submarine cables on the migration behaviour of marine mammals is largely unknown (GILL et al. 2005). However, since the magnetic fields occurring are significantly below the Earth's natural magnetic field, no significant effects on marine mammals are to be expected.

As a result of the SEA, it can be stated that according to available information, no significant effects on marine mammals as a protected asset are to be expected from the laying and operation of submarine cable systems.

4.6 Seabirds and resting birds

The individual parts of the North Sea are of differing significance for seabirds and resting birds. For breeding birds, the sites provided in the Site Development Plan for the development of wind farm projects, but also platforms, are of no particular importance due to the distance to the coast and the islands, with the breeding colonies as feeding grounds. Protected bird species listed in Annex I of the Birds Directive occur at different densities in the areas designated for wind farms or platforms and their surroundings.

All the information available to date indicates that areas N-1, N-2 and N-3 are of medium importance for seabirds, including species listed in Annex I of the Birds Directive. Area N-4 is of only medium importance for most seabird species; however, it falls within the identified main concentration area for divers in the German Bight in spring and is therefore of great importance. Area N-5 is also located within the main concentration area for divers in the German Bight and in parts in the immediate vicinity of subarea II of the "Sylt Outer Reef – Eastern German Bight" nature reserve. The surroundings for this area are home to a high number of divers susceptible to disturbance and other protected species listed in Annex I of the Birds Directive and are therefore of great importance for seabirds. The region of areas N-6 to N-13 lie outside the concentration centres of various bird species listed in Annex I to the Birds Directive, such as divers, terns and little gulls. Deep-sea bird species with very large distribution areas in the entire North Sea and populations with high numbers of individuals, such as guillemots and northern fulmars, predominantly occur here. Areas N-6 to N-13 are of only medium importance for seabirds, according to available information.

4.6.1 Areas and sites

Due to construction: Effects on seabirds and resting birds are to be expected during the construction of offshore wind turbines, although their nature and extent will be limited temporally and spatially.

Avoidance of the construction site is to be expected in the case of species susceptible to disturbance. In this context, construction-related shipping traffic will not exceed the extent of the impact that regular shipping already has on seabirds in some areas of the German North Sea. Moreover, the planning principles on which the Site Development Plan is based provide for temporal and spatial coordination of construction projects and a reduction in the volume of shipping traffic. Turbidity plumes will also occur only locally, and for a limited time. Attraction due to site lighting and site vehicles cannot be ruled out. Corresponding ancillary provisions for minimising emissions are included in the individual approval procedures, however, in order to reduce these to a necessary minimum.

Finally, due to the generally high mobility of birds and the measures to be taken to avoid and reduce intensive disruptions, significant effects on all species of seabirds and resting birds during the construction phase can be excluded with the necessary certainty.

Due to operation and the installation: Erected wind turbines may present an obstacle in the air and may also cause collisions of seabirds and resting birds with the vertical structures (GARTHE 2000). It is difficult to estimate the extent of such incidents to date, as it is assumed that the majority of birds that collide with solid structures are not seen (HÜPPOP et al. 2006). However, for species susceptible to disruption, such as red-throated divers and black-throated divers, the collision risk is very low as they do not fly directly to or near wind farms due to their avoidance behaviour. Furthermore, factors such as manoeuvrability, altitude and proportion of time spent flying determine the collision risk of a species (GARTHE & HÜPPOP 2004). The risk of collision for seabirds and resting birds must therefore be assessed differently for each species.

Within the framework of StUKplus, the flight altitude distribution of a total of seven species of seabirds and resting birds was determined using Rangefinder in the "TESTBIRD" project. European herring gulls, lesser black-backed gulls and great black-backed gulls, all large seagull species, flew at altitudes of 30 – 150 m in the majority of flights recorded. Species such as black-legged kittiwakes, common gulls, little gulls and gannets, on the other hand, were mainly observed at lower altitudes of up to 30 m (MENDEL et al. 2015). A recent study at the British Thanet Offshore Wind Farm investigated the flight altitude distribution of gannets, black-legged kittiwakes and the large seagull species European herring gulls, great black-backed gulls and lesser black-backed gulls, also using the Rangefinder (SKOV et al. 2018). The flight altitude measurements for the large seagulls and the gannets showed heights comparable to those identified by Mendel et al. (2015). Black-legged kittiwakes, on the other hand, were mostly observed at heights of about 33 m.

To estimate the potential risk of seabirds and resting birds colliding with wind turbines at sea, the corresponding height parameters of the turbines are an important indicator. In accordance with current technical developments with regard to the dimensions of future wind turbines, scenarios were included in the Site Development Plan which take the altitude parameters into consideration (see chapter 1.1.10 of the environmental report). Wind turbines with a hub height of 125 m and a rotor diameter of 198 m would be used in scenario 1, thereby reaching a total height of 224 m. In scenario 2, the wind turbines would have a hub height of 175 m, a rotor diameter of 250 m and a total height of 300 m. This means that the lower, rotor-free area from the surface of the water to the lower tip of the rotor blade would be 26 m in scenario 1 and 50 m in scenario 2.

In general, large and small seagulls are highly manoeuvrable and can react to wind turbines with corresponding evasive manoeuvres (GARTHE & HÜPPOP 2004). This was also shown by the study by SKOV et al. (2018), in which not only the flight altitude but also the immediate, small-scale and large-scale evasive behaviour of the species in question were investigated. Furthermore, the surveys by means of radar and a thermal imaging camera showed low nocturnal activity. The risk of collision at night due to attraction as a result of illumination of the wind turbines can therefore also be deemed to be low.

The terns listed in Annex I of the Birds Directive are not at risk of collision with the installations either, as they prefer low altitudes and are extremely agile flyers (GARTHE & HÜPPOP 2004).

Overall, the implementation of the wind turbines at the sites as specified in scenarios 1 and 2 in the Site Development Plan will not involve an increased risk of collision for seabird and resting bird species. According to available information, this also applies to species whose flight altitudes are in the vicinity of the rotating rotor blades. Furthermore, the exclusion of wind farm projects in conservation areas minimises the risk of collisions in important feeding grounds and resting areas in the EEZ.

In the case of species susceptible to disruption, avoidance of the wind farm sites to extents specific to species and areas is to be assumed during the operating phase of the wind farms.

Red-throated divers and black-throated divers display strong avoidance behaviour towards offshore wind farms. From the wind farm projects in area N-5, current results from ongoing operational monitoring show significant mean deterrent distances of 10 or 11 km (BIOCONSULT SH & Co.KG 2017, BIOCONSULT SH & Co.KG 2018) or approximately 15 km (IFAÖ 2018). Effects on the distribution of divers up to a distance of 10 km from the wind farm could be demonstrated for wind farm projects in area N-4 (IBL UMWELTPLANUNG GMBH et al. 2017a, IBL UMWELTPLANUNG GMBH et al. 2018). Effects up to 2 – 4 km were observed for areas N-1 to N-3 (IFAÖ et al. 2017). Within the framework of a current study by the Research and Technology Centre (FTZ) on behalf of BSH and BfN, which took into consideration not only data from wind farm monitoring in the EEZ but also research data and data from Natura 2000 monitoring, a statistically significant decrease in diver abundance was identified for all developed areas in the EEZ up to 10 km, starting from the periphery of a wind farm (GARTHE et al. 2018). The DIVER research project used an independent method to determine avoidance effects using radio marking (telemetry) of divers in the German EEZ, besides the usual digital aircraft-based recording of seabirds and resting birds. The telemetric surveys of the DIVER research project were also able to identify significant avoidance effects up to a distance class of 10 – 15 km from the region of the wind farms in areas N-4 and N-5 (BURGER et al. 2018). The large-scale digital surveys carried out west of Sylt as part of the HELBIRD research project resulted in statistically significant avoidance effects up to 16.5 km away from a wind farm, the increase in diver density being at its strongest further away, within 10 km of the wind farm (MENDEL et al. 2019). It should be noted that the distances referred to above relate not to total avoidance, but to partial avoidance with increasing diver densities up to the corresponding distances from a wind farm. One thing all these surveys have in common is the observation that divers avoid the actual wind farm site (footprint).

To quantify habitat loss, early decisions on individual approval procedures were based on a deterrent distance of 2 km (defined as complete avoidance of the wind farm site, including a buffer zone of 2 km) for divers. The assumption of a 2 km habitat loss was based on data from monitoring of the Danish "Horns Rev" wind farm (PETERSEN et al. 2006). The current study by GARTHE et al. (2018) shows an average of 5.5 km, more than twice the deterrent distance. This deterrent distance, or calculated complete habitat loss, is subject to the purely statistical assumption that there are no divers up to a distance of 5.5 km from an offshore wind farm.

All available results from research and monitoring agree that the avoidance behaviour of divers towards wind farms is much more pronounced than was previously assumed.

For other species such as gannets, guillemots and razorbills, as well as little gulls, information is available on small-scale avoidance behaviour towards wind farms (e.g. SKOV et al. 2018, IFAÖ et al. 2017, IBL UMWELTPLANUNG GMBH et al. 2017a, IBL UMWELTPLANUNG GMBH et al. 2018). On account of their widespread distribution in the EEZ, it cannot be assumed at present that these species will be severely affected.

The Site Development Plan will also define specifications regarding the consideration of best environmental practice and the relevant state of the art. In this context, regulations on the prevention and reduction of adverse impacts on seabirds and resting birds due to the construction and operation of wind turbines, in particular in the form of measures to minimise pollutant and light immissions, are to be adopted at approval level. This corresponds to the current approval practice.

Furthermore, it is not possible to rule out the recovery of fish populations during the operating phase as a result of a fishing ban within the wind farm, which will be accompanied by a ban on ships. Besides the introduction of hard substrate, the species composition of the fish present could thus increase and provide an attractive food supply for seabirds searching for food. Significant impairment cannot be predicted for this aspect.

4.6.2 Platforms

Due to construction: Direct disruptions to seabirds due to deterrence are to be expected during the construction phase, at most locally and limited in terms of time. Due to the high mobility of birds and the measures to be taken – in the respective individual approval procedures – to avoid and reduce intensive disturbances, considerable effects can be excluded with a high degree of certainty. The construction of platforms is limited spatially, so any effects such as avoidance behaviour or attraction from construction ships can only occur locally.

However, given the existing prior impact from shipping traffic, the effects of traffic due to construction will not lead to a significant increase in disturbances and deterrence. In summary, therefore, it can be stated that the disturbances or impairments to seabirds that may be associated with construction operations are to be assessed as minor.

Due to operation and the installation: According to available information, platforms are not expected to have a significant impact on seabirds and resting birds during the operating phase. The platforms will be constructed in the immediate vicinity of the wind farms. Thus any effects from the platforms will not go beyond the extent of the possible effects of the directly adjacent wind farms.

Should the benthic species composition change in the vicinity of the platforms and wind farms, this change could attract fish and predators such as seabirds. However, the effects of sediment changes and benthos changes in the immediate vicinity of the platforms would remain insignificant for seabirds, as they predominantly search for their prey organisms in very extensive areas in the water column. Deterrence due to shipping and helicopter traffic during maintenance and repair work may occur for a limited period of time during the operation of the platforms.

Offshore platforms have often been found to be used as resting places by many bird species. Therefore, it is not possible to exclude attraction to the platforms for many seagull species.

The Site Development Plan will also define specifications regarding the consideration of best environmental practice and the relevant state of the art. In this context, regulations on the prevention and reduction of adverse impacts on seabirds due to the construction and operation of platforms, in particular in the form of measures to minimise pollutant and light immissions, are to be adopted at approval level. This corresponds to the current approval practice.

Significant effects on seabirds and resting birds due to the construction and operation of platforms can therefore be excluded with the necessary certainty.

4.6.3 Submarine cabling systems

According to available information, the laying and operation of submarine cable systems is not expected to have any significant effects on seabirds and resting birds. Short-term deterrence may occur due to construction-related shipping traffic, but only during the installation phase, which is limited temporally and spatially. However, these effects will not go beyond the disruptions generally associated with slow ship movements. Significant effects on resting birds due to construction-related turbidity plumes or due to sediment changes and benthos changes in the vicinity of the crossing structures are not to be expected either, as these birds seek their prey in very extensive areas in the water column.

Installation-related and operational effects of the planned submarine cable systems on seabirds and resting birds can be excluded with the necessary certainty. A possible collision risk due to construction vehicles can be classified as very low due to the short-term nature of the construction phase.

In summary, it can be stated that considerable effects on seabirds and resting birds as a protected asset due to the laying and operation of submarine cable systems can be excluded with the necessary certainty.

4.7 Migratory birds

The North Sea EEZ is of average to above-average importance for bird migration. It is assumed that considerable numbers of songbirds breeding in Northern Europe migrate across the North Sea. However, there are no leading lines or concentration ranges for bird migration in the EEZ. Special migratory corridors cannot be identified for any migratory bird species in the vicinity of the North Sea EEZ northwest of the East and North Frisian islands, as bird migration takes place either in a guiding principle-oriented coastal area or as broad-front migration over the North Sea that cannot be defined in greater detail. There are indications that migration intensity decreases further away from the coast. At present, however, this has not yet been clarified for the mass of songbirds that migrate at night.

The following general impairments and effects may occur during the implementation of the Site Development Plan and hence the construction of offshore wind farms, transformer stations and converter platforms:

Due to construction: In the first instance, disturbances during the construction phase will be caused by light emissions and visual upheaval. These may cause varying degrees of deterrence and barrier effects on migratory birds, depending on the species. However, the lights from construction equipment may also attract migratory birds and increase the risk of collision.

Due to the installation and operation: The planned offshore wind farms may present a barrier to migratory birds or a risk of collision during the operating phase. Avoidance of structures or other disturbances of flight behaviour will lead to a higher energy consumption, which may impact on the fitness of the birds and, consequently, their survival rate or breeding success. Bird strikes may occur on vertical structures (such as rotors and supporting structures for wind turbines, transformer stations and converter platforms). Poor weather conditions – especially at night and in strong winds – and high migration intensities increase the risk of bird strikes. Moreover, glare or attraction may be caused by the safety lights for the installations and may lead to birds losing their bearings. Furthermore, the manoeuvrability of birds caught in wake flows and air turbulence at the rotors could be impaired severely. However, as with the deterrent and barrier effects, it can be assumed that the susceptibilities and risks in respect of the aforementioned factors vary from species to species.

As a general rule, bird migration will not be endangered if there is an abstract risk that single individuals will come to harm as they migrate through an offshore wind farm. A risk to bird migration will only be present if sufficient information justifies the prediction that the number of birds that may potentially be affected is such that significant impairment of one or more different populations could be assumed with sufficient probability, taking into account their respective population sizes. The biogeographical population of the migratory bird species in question provides the reference value for quantitative observation.

There is agreement that, under existing legislation, individual losses must be accepted during bird migration. In particular, it must be borne in mind that bird migration in itself already entails many dangers and that populations are subjected to harsh selection. The mortality rate for small birds can be about 60 to 80%, while the natural mortality rate is lower for larger species. The individual species also have different reproduction rates, which means that the loss of individuals for each species can have different implications.

A generally valid acceptance limit has not yet been determined due to the absence of conclusive findings. However, the threshold value of one percent, which is often used by experts in avifaunistic studies, can be used at least as a guideline.

The potential danger for the respective biogeographical population lies firstly in the loss due to bird strikes and secondly in other adverse effects that may result from forced changes in flight routes.

According to the environmental report for the Spatial Plan for the German Exclusive Economic Zone (EEZ) in the North Sea (FEDERAL MARITIME AND HYDROGRAPHIC AGENCY 2009), the species-specific individual assessment showed that no significant negative impacts are expected for most migratory bird species occurring in the EEZ of the North Sea or their biogeographical populations. To prevent any risks to bird migration, in particular to the species above, risk-mitigation measures should be imposed in the approval procedure.

In addition to the threat to bird migration posed by bird strikes, another risk for migrating birds is the possibility that the migratory route could be diverted by the presence of wind turbines and thus extended. However, this does not affect bird migration in its entirety as a large part of migration takes place at altitudes outside the range of influence of wind turbines. Many songbirds, for example, migrate at altitudes between 1,000 and 2,000 m. Wading birds are also known to migrate at very high altitudes (JELLMANN 1989). However, significant numbers migrate at altitudes <200 m and thus within the range of influence of the wind turbines. Many of the low-flying migratory species belong to the group of waterfowl and seabirds that are able to land on water to rest and feed if necessary. For species like these, any diversions are therefore of little consequence. They could, however, be problematic for migrating land birds that are not able to land on water. It is important to bear in mind that migratory birds are capable of flying impressive distances without stopping, especially when non-water species migrate across oceans. Many species, even small birds, can fly more than 1,000 km without stopping (TULP et al. 1994). It is therefore not expected that the additional energy needed in the EEZ of the North Sea would endanger bird migration, provided that there are no continuous crossbars in the main direction of migration.

These projections are confirmed by the findings of AVITEC RESEARCH (2017), which do not indicate any threat to bird migration from the construction or operation of wind farms in the "North Borkum" area (AVITEC RESEARCH 2017).

Furthermore, comparisons of the results of operational monitoring with the basic analyses provided no clear indication of the effects of the operation of 'DanTysk' in the "Western Sylt" area (BIOCONSULT SH 2017).

4.7.1 Areas and sites

Since the marine areas of the sites do not differ significantly in terms of their importance for bird migration, this does not give rise to any divergent risk in the development of offshore wind farms. Previous findings of monitoring studies (AVITEC RESEARCH 2017, BIOCONSULT SH 2017) have not provided any evidence of significant adverse impacts on bird migration.

It must be noted here that the previous wind turbines did not exceed the total height of 200 m, which is the basis for the previous impact forecasts. The future plans according to the Site

Development Plan, on the other hand, envisage two scenarios in order to account for current technical developments. Scenario 1 assumes a hub height of 125 m, a rotor diameter of 198 m and a total height of 224 m, with the height of the lower rotor tip at 26 m. In scenario 2, the corresponding values are 175 m, 250 m, 300 m and 50 m. Due to these larger dimensions, the swept area of the rotor also increases. However, this influence is reduced as the number of turbines decreases. The higher turbines, however, can increase the risk of collision.

Altitude profiles obtained through observations of migratory plans by a visual observer in the "Northern Borkum" cluster (AVITEC RESEARCH 2017) show a strong concentration on altitude ranges up to 20 m. While 85% of the birds identified migrated at this altitude in spring, almost three quarters did so in autumn. Migratory activities visible during the day primarily (92%) took place at flight altitudes of less than 20 m in the "Western Sylt" cluster (BIOCONSULT SH 2017). Overall, 8.0% of flights took place within the potential risk area of the rotors (20–200 m). In the case of divers, geese and songbirds, more than one third of the individuals were recorded in the potential hazardous zone of the rotors.

Previous investigations of bird migration using vertical radar in the EEZ in the North Sea showed that the altitude distribution was dependent on the time of day. During the day, bird migration in spring concentrated on lower altitudes because more than half of all radar echoes recorded with daylight were at altitudes of up to 300 m. While the number of bird echoes recorded during the day continuously decreased as altitude increased, a bimodal distribution pattern for the recorded bird movements was observed in the dark. At night, both the lowest altitude ranges up to 100 m (35,018 flights; 13.2%) as well as the highest ranges between 900 and 1,000 m (30,295 flights; 11.4%) were the most frequented. About one third of the echoes were each recorded at altitudes up to 300 m, above 300 m to 700 m and above 700 m to 1,000 m (AVITEC RESEARCH 2017). Corresponding to the conditions in spring, however, bird migration with altitude profiles different from the basic pattern were also recorded at night in autumn. In the busy bird migration night of 25/26 October, the altitude range above 900 m to 1,000 m was the most frequented, suggesting that bird migration that night was underestimated, and a high (but unknown) percentage of migrating birds flew above the radar measurement range. By comparison, bird migration also shifted heavily to the higher altitudes during the very busy bird migration night 9/10 November. Avitec Research therefore assumes that its vertical radar system, with its data basis of up to an altitude of 1,000 m, records an average of at least 2/3 of all bird migration. In individual cases, the percentage of bird migration may be significantly higher, depending on the vertical wind profile. Conversely, on nights with an altitude distribution that decreases only slowly or even increases, more than half of all migratory birds are missed. However, this is usually only the case for a small number of nights.

If we consider the low flight altitudes of the birds migrating during the day, most of which fly below 20 m and thus also below the lower rotor tip according to above scenarios 1 and 2, no significant impacts can be expected for birds that migrate during the day as a result of planning in the Site Development Plan.

Taking into account the migratory patterns, there is a particular risk of collision for small birds migrating at night as a result of migration in the dark, high migratory volume and the strong attraction of artificial light sources.

As already described, migrating birds tend to fly higher in good weather than in bad weather. It is also an undisputed fact that most birds usually start their migration in good weather and are able to choose their departure conditions in such a way that they are reasonably likely to reach their destination in the best possible weather (Federal Maritime and Hydrographic Agency 2009). In the clear weather conditions preferred by the birds for migration, the probability of a collision with a wind turbine is therefore low because the flight altitude of most birds will be above the range of the rotor blades and the turbines are clearly visible. A potentially dangerous situation, on the other hand, is posed by unexpected fog and rain, which lead to poor visibility and low flight altitudes. A particular problem is when bad weather conditions coincide with what are known as mass migration events. According to information from various environmental impact studies, mass migration events in which birds of various species fly across the North Sea at the same time occur approx. 5 to 10 times a year. On average, two to three of them take place during bad weather. Consequently, even the larger turbines in scenarios 1 and 2 are not expected to have any significant effects according to the current state of knowledge.

However, the risk of collision may vary depending on existing offshore wind farms in the marine areas. This applies for the marine areas of areas 3, 5, 6 and 8. Wind turbines that are up to 50 m lower in scenario 1 and up to 120 m lower in scenario 2 have already been built in these areas. This creates a staircase effect, which limits the visibility of the higher turbines as they can only be partially seen. This is particularly true for scenario 1 as here primarily the turning rotors will be visible. In scenario 2 with a hub height of 175 m, the massive nacelle will usually also be visible. The following assessment of the collision risk is based on the main migration directions northeast (spring) and southwest (autumn).

Wind turbines 153 m and 187 m high have been constructed in the southern area of area 3. Turbines with a height of 187 m have been built in the north-eastern part. The above-mentioned "staircase effect" arises for the projects **N-3.5, N-3.6** and **N-3.8**. This is not the case in autumn as migratory birds first encounter the high turbines. However, this effect occurs for area **N-3.7** during both migration periods.

A wind turbine approx. 160 m in height exists in the north-western part of area 5. As a result, this staircase effect for area **N-5** occurs only partially in spring.

For the marine area of area **N-6.6**, the risk is only potentially elevated in autumn, since the existing wind turbines with heights of 151 to 190 m are located in the north.

A wind farm is being planned in the north of area 7. A risk assessment can therefore not be carried out for areas **N-7.2** and **N-7.3** at present.

The entire southern part of area 8 has turbines with a height of 150 to 182 m, so the migratory birds in spring only encounter the lower turbines in area **N-8.4**.

There are no existing offshore wind farms in the immediate vicinity of the main migration directions in marine areas **N-9.1** and **N-9.2**, **N-10.1** and **N-10.2** as well as **N-12.1**.

Despite the possible increased risk of collision due to the step-by-step expansion, based on the above statements, it can be asserted for the Strategic Environmental Assessment (SEA) that, according to the current state of knowledge, the planned offshore wind farm projects are unlikely to have any significant effects on migratory birds. However, any increased risk of collision due to the higher turbines should be taken into account when planning the individual projects.

4.7.2 Platforms

In the clear weather conditions preferred by the birds for migration, the probability of a collision with a converter platform is very low because the flight altitude of most birds will be far above the turbine height and also the rotor height of the surrounding wind turbines and the turbines are clearly visible. Bad weather conditions increase the risk. Since the converter platforms are individual structures, which are also routinely planned in the immediate vicinity of offshore wind farms, no significant impairment of bird migration is to be expected. It can also be assumed that any negative impacts during the operating phase of the converter platforms can be reduced by lighting that is as compatible as possible and minimises the attraction. This includes, for example, the selection of suitable light intensities and light spectra or lighting intervals.

Based on the above statements, it can be asserted for the SEA that, based on the current state of knowledge, the planned converter platforms are unlikely to have any significant effects on migratory birds. Potential cumulative effects of the converter platforms in combination with the offshore wind farms are discussed in chapter 4.12.

4.7.3 Submarine cabling systems

Installation-related and operational effects of the planned submarine cable systems on migratory birds can be excluded with the necessary certainty. A possible collision risk due to construction vehicles can be classified as very low due to the short-term nature of the construction phase.

4.8 Bats and bat migration

Migration movements of bats across the North Sea are still scarcely documented and largely unexplored. There is a lack of specific information on migratory species, migration corridors, migration heights and migration concentrations. Information available to date confirms merely that bats, especially species that travel long distances, fly over the North Sea.

4.8.1 Areas and sites

The possibility of collisions of individuals with offshore wind turbines cannot be ruled out. At present, however, too little is known about migratory corridors and migratory behaviour of bats over the North Sea to realistically assess a threat. It can be expected that any adverse impacts on bats can be prevented and reduced by the same measures used to protect bird migration.

4.8.2 Platforms

Dangers to individuals due to collisions with platforms cannot be ruled out. However, as the platforms are individual structures situated in the immediate vicinity of offshore wind farms, the possibility that flying or possibly migrating bats will be significantly impaired can be ruled out based on the current state of knowledge. It can also be expected that any negative effects on bats can be prevented by using the same prevention and mitigation measures devised to protect bird migration.

4.8.3 Submarine cabling systems

The possibility that bats will be significantly affected by laying and operating submarine cable systems can be excluded with the necessary certainty.

4.9 Climate

Adverse impacts on the climate due to the construction and operation of converter platforms are not expected, as there are no measurable emissions relevant to climate during construction or operation. Rather, the coordinated expansion of offshore wind energy and grid connections will increase planning reliability for the expansion of offshore wind energy.

The CO2 savings associated with the expansion of offshore wind energy are expected to have a positive impact on the climate in the long term. This may make an important contribution to achieving the Federal Government's climate protection targets.

4.10 Landscape

4.10.1 Areas and sites

As outlined in chapter 3.14, the creation of offshore wind farms in the areas defined by the Site Development Plan will have an impact on the landscape as a factor as it will be altered by the construction of vertical structures and safety lighting. The scope of these visual impairments to the landscape caused by the planned offshore turbines will depend to a large extent on the respective visibility conditions. Due to the considerable distance of more than 30 km between the planned sites and the North Sea coast, the installations will only be visible to a very limited extent from land (HASLØV & KJÆRSGAARD 2000), and only when visibility is good. This also applies to navigation lights for safety purposes at night. Due to subjective sensitivities and the fundamental attitude of the viewer towards offshore wind energy, the vertical structures – which are atypical for a marine and coastal landscape – can be perceived as both disturbing and technically interesting. In any case, they will bring about a change in the landscape and modify the character of the area.

Beyond the coast, the visual impairment of the landscape changes with greater spatial proximity to the offshore areas. The type of use is the key factor here. The value of the landscape plays a secondary role in industry and transport. The landscape, however, is very important for recreational use, as in the case of water sports enthusiasts and tourists. However, direct use for recreation and leisure by recreational and tourist boats is only sporadic in the planned wind farm areas. These are mainly located in areas used by shipping and the offshore industry, which means that the impact on the recreational use of water sports enthusiasts is considered low.

As a result, the impact on the landscape of the planned wind turbines along the coast can be classified as low. Since the Spatial Plan for the North Sea EEZ contains a height limit of 125 m above sea level, height deviations are clarified in the procedure for obtaining permission for deviation from objectives pursuant to the Federal Regional Planning Act (Raumordnungsgesetz, ROG). The results from an ongoing procedure for deviation from objectives remain to be seen.

The rules in the Site Development Plan can minimise the area required through coordinated and coherent overall planning and thus – compared to non-implementation of the plan – also reduce the impact on the landscape as a factor.

For the submarine cable systems, adverse impacts on the landscape can be ruled out as they will be laid as underwater cables.

4.10.2 Platforms

As previously described for the wind farm areas and sites, the construction of platforms can also bring about visual changes in the landscape. As these platforms are always planned in close proximity to or physically connected to the wind energy areas, the change in the landscape caused by these individual structures is only marginally increased. In addition, the platforms are more than 30 km from the coast and will only be visible from land to a very limited extent (as will their safety lighting).

4.11 Interdependency

In general, effects on a factor lead to various consequences and interrelationships between the factors. Impacts on the soil or water body thus usually also affect the biotic factors in these habitats. For example, emissions of pollutants can reduce water and/or sediment quality and be absorbed by benthic and pelagic organisms from the surrounding medium. The essential interdependence of the biotic factors results from the food chains. These correlations between the different factors and possible impacts on biodiversity are described in detail for the respective factors.

Possible interactions during the construction phase will result from sediment shifts and turbidity plumes, as well as noise emissions. However, these interdependencies will occur only very briefly and be limited to a few days or weeks.

Sediment shifts and turbidity plumes

Sediment shifts and turbidity plumes occur during the construction phase of wind farms and platforms or when submarine cables are laid. Fish are temporarily deterred. The macrozoobenthos is covered locally. Consequently, the feeding conditions for benthos-eating fish and for fish-eating seabirds and harbour porpoises also change temporarily and locally (decrease in the supply of available food). However, due to the mobility of the species and the temporal and spatial limitation of sediment shifts and turbidity plumes, the possibility of considerable impairments to the biotic factors and thus to the existing interdependencies between them can be eliminated with the necessary certainty.

Noise emissions

The installation of the foundations of the converter platforms can lead to temporary flight responses and temporary avoidance of the area by marine mammals, some fish species and seabird species. In contrast, large gulls are attracted by construction activities. On the other hand, if seabirds sensitive to disturbances avoided the area, the risk of bird strikes would be reduced.

Mutual interdependencies in the operating phase are to be expected on a permanent basis, but generally limited to the respective area or site. Possible impacts on the interdependencies for platforms and submarine cable systems can only be expected locally.

Area use

When foundations are introduced, benthic biocoenoses are locally depopulated, which can result in a potential deterioration of the food base for the fish, birds and marine mammals that follow in the food pyramid. However, the loss of feeding areas due to area sealing does not result in any impairments for benthos-eating seabirds in deeper water as the water is too deep to search for food effectively.

Introduction of artificial hard substrate

The introduction of artificial or non-local hard substrate (platform foundations, cable intersections) results in a local change in soil composition and sediment conditions. The composition of the macrozoobenthos may change as a result. According to KNUST et al. (2003), the introduction of artificial hard substrates into sandy soils leads to the colonisation of additional species. The recruitment of these species will most likely take place from the natural hard substrate habitats, such as superficial till and rocks.

Thus there is little risk of atypical species having a negative influence on sandy bottom benthic communities. However, colonisation areas of the sandy soil fauna are lost in these places. By changing the species composition of the macrozoobenthos population, the food resources for the fish biocoenoses at the site can be influenced (bottom-up regulation).

Certain fish species could be attracted, which in turn increasingly prey on the benthos and thus shape the dominance relationships by selecting certain species (top-down regulation).

Prohibition of use and navigation

Fishing is prohibited within and around wind farms and platforms. The resulting elimination of fishing can lead to an increase in the population of both fishing target species and unutilised fish species; a shift in the length range of these fish species is also conceivable. If fish populations grow, the food supply for marine mammals can be expected to increase. A macrozoobenthos community undisturbed by fishing activity is also expected to develop. This could mean that the diversity of the species community will increase as sensitive and long-living species of the current epi- and infauna have better chances of survival and stable populations develop.

Interrelationships can only be described very imprecisely due to the variability of the habitat. It can generally be said that the implementation of the Site Development Plan does not currently have any discernible effects on existing interdependencies that could endanger the marine environment. The SEA therefore concludes that the definition of sites and areas for offshore wind turbines and platforms and the definition of submarine cable routes in the Site Development Plan are not expected to have any significant impacts on the living marine environment as a result of interdependencies according to the current state of knowledge, but rather that adverse impacts can be prevented when compared to non-implementation of the plan.

4.12 Cumulative effects

The assessment of cumulative impacts of uses is all the more important for drawing up the land-use development plan, as these are very complex correlations which, if considered individually, would not identify the scope of any potential threat to the marine environment.

The assessment of cumulative effects stems from a number of legal obligations:

- Offshore Wind Energy Act (WindSeeG), part 2, section 1: section 5 subsection 3 no. 2 WindSeeG: *Provisions pursuant to subsection 1 nos. 1 and 2 and 6 to 11 shall be inadmissible if overriding public or private interests conflict therewith. These provisions are in particular inadmissible if … 2.* ***they endanger the marine environment****,*
- Environmental Impact Assessment Act (UVPG): section 2 subsection 2 UVPG *Environmental impacts in the sense of this act are* ***direct and indirect impacts*** *of a project or the implementation of a plan or programme on the factors* and from section 3 UVPG *Environmental assessments ……. serve the purpose of effective preventive environmental precautions in accordance with the applicable laws,*
- Federal Nature Conservation Act (BNatSchG) and regulations for the designation of nature conservation areas in the German EEZ, e.g. section 34, subsection 1 of the Federal Nature Conservation Act (assessment of the implications): *Prior to the approval or the implementation of projects, their compatibility with the conservation objectives of a Natura 2000 site shall be assessed, if they,* ***either individually or in combination with other projects or plans****, have the potential to affect the site significantly, and do not directly serve the purpose of the site's management and section 44, subsection 1 no. 2 of the Federal Nature Conservation Act: (prohibition of disturbance) …. a disturbance shall be deemed significant if it causes the*

conservation status of the local population of a species *to worsen*.

4.12.1 Soil/area, benthos and biotopes

A significant proportion of environmental effects on soil, benthos and biotopes due to the areas and sites, platforms and submarine cable systems will occur solely during the construction period (formation of turbidity plumes, sediment shifts, etc.) and over a limited area. Cumulative environmental effects due to construction are unlikely, particularly due to the step-by-step implementation of the construction projects. Possible cumulative effects on the seabed, which could also have a direct impact on the factor Benthos and specially protected biotopes, result from permanent direct area use due to the foundations of the wind turbines and platforms, as well as from the installed cable systems. The individual effects are essentially small-scale and local.

In order to estimate the direct area use, a rough calculation is made in the following section on the basis of the areas/sites, platforms and submarine cable systems planned in the Site Development Plan in conjunction with existing installations and planning within the framework of the transitional system. The calculated area use is based on ecological aspects; in other words, the calculation is based on the direct ecological loss of function or the possible structural change of the site due to the installation of foundations and cable systems. In the area of the cable trench, however, the impairment of the sediment and benthic organisms will essentially be temporary. Permanent impairment could be assumed when crossing particularly sensitive biotopes such as reefs or species-rich gravel, coarse sand and shell layers.

According to a model assumption, there will be a mostly temporary loss of function over a site of around 335 ha due to existing cables, cables in the transitional system and the submarine cable systems provided for in the Site Development Plan. The calculation is based on the assumption of a cable trench 1 m wide. The necessary intersections also have to be taken into account here. Based on an area per intersection of approx. 900 m², the direct area use for approx. 400 intersections amounts to a total of approx. 36 ha. In addition to this, a total of 0.96 ha of area used will be taken up by 16 converter platforms with associated scour protection (600 m² per platform). For the Site Development Plan rules in the areas, the parameters of scenario 2 of the model wind farm were used as a basis for a conservative estimate (number of installations calculated in accordance with the stated capacity, diameter of the foundation and diameter of any scour protection required, number of platforms). In contrast, the model wind farm parameters of scenario 1 were used to calculate area use within the framework of the transitional system, assuming that no installations in the dimension of scenario 2 will be implemented in the transitional system. The functional loss due to the cabling within the wind farm was calculated in accordance with the capacity shown, assuming a cable trench 1 m wide. On the basis of this conservative estimate, approx. 315 ha of land will be used for the areas and sites by means of the Site Development Plan rules, planning within the framework of the transitional system and the existing systems, or temporarily impaired in the case of the farm's internal cabling.

In total, about 686 ha of area will be used or, in the case of submarine cables, temporarily impaired, corresponding to about 0.25‰ of the total EEZ area. The nature conservation sites account for a total area of around 27% of the North Sea EEZ. Since the construction of wind turbines and converter platforms in nature conservation areas is generally not permitted (see Objective of spatial planning 3.5.1 (3) and, inter alia, planning principle 4.4.2 Site Development Plan), the spatial use of the protected areas is limited to submarine cable routes and intersections as well as the exceptional case of Butendiek. No statement can be made on the use of specially protected biotopes according to section 30 of the Federal Nature Conservation Act due to the absence of a sound scientific basis. Area-wide sediment and biotope mapping of the EEZ currently being carried out will provide a more reliable basis for evaluation in the future.

Besides the direct use of the seabed and hence the habitat of the organisms living there, the foundations and intersections will lead to an additional supply of hard substrate. This allows non-local species with a preference for hard substrates to colonise and change the species composition. This effect can lead to cumulative impacts due to the construction of several offshore structures or rockfill at intersections of submarine cable systems with other cables or pipelines. The benthic fauna adapted to soft substrates will also lose habitat on account of the hard substrate. However, as the area use for both the grid infrastructure and the wind farms will be in the ‰ (per-mille) range, according to current knowledge, no significant impairments are to be expected in the cumulation that would endanger the marine environment with regard to the seabed and the benthos.

4.12.2 Fish

Understanding the interactions between the installation of wind farms in the North Sea and the ecology of the fish makes it possible to predict the cumulative effects of this new development. As a result of the operation of offshore wind farms, the area where fishing is not permitted will increase. These non-fishing zones could have a positive impact on the North Sea fish biocoenoses by eliminating negative fishing impacts such as disturbance or destruction of the seabed and catch and by-catch of many species. These areas could develop into places that attract fish, although it has not yet been conclusively clarified whether wind farms attract fish and, if so, why. In addition to the absence of fishing, improved food resources for fish species with different feeding habits would also be conceivable. The growth of sessile invertebrates on the wind turbine foundations could encourage benthos-eating species or cause a change in the food composition of species that have previously eaten otherwise. The wind farms could have an additive effect beyond their immediate location by distributing the mass and measurable production of planktonic distribution stages of the benthic organisms growing on the foundations by currents and thus influencing the qualitative and quantitative composition of the zooplankton (FLOETER et al. 2017). This, in turn, could have an impact on planktivore fish, including pelagic schooling fish such as herring and sprat, which are targets of one of the largest fisheries in the North Sea. The species composition could also change directly, as species with different habitat preferences than the established species, e.g. reef dwellers, find more favourable living conditions and become more prevalent. So far, there are no signs of this in either the pelagic or the demersal component of the fish community. (LEONHARD et al. 2011). However, in the Danish wind farm Horns Rev, a horizontal gradient was found between the surrounding sandy areas and near the turbine foundations 7 years after construction: species with an affinity for hard substrates including the goldsinny wrasse *Ctenolabrus rupestris*, viviparous eelpout *Zoarces viviparous* and lumpsucker *Cyclopterus lumpus* near the wind turbine foundations were much more frequent than on the surrounding sand surfaces (LEONHARD et al. 2011). No effects of the wind farm could be demonstrated for sand eels, one of the most important fishing resources in the North Sea. The cumulative effects of an extensive expansion of offshore wind energy could include

- further establishment and distribution of fish species adapted to reef structures

- the recolonisation of areas and sites previously subject to intensive fishing, including sand eels
- better living conditions for territorial species such as fish similar to cod

The natural mechanism for limiting populations, besides predation, is intra- and interspecies competition, also known as density limitation. The possibility cannot be ruled out that local density limits may occur within individual wind farms before the favourable effects of the wind farms spread geographically, e.g. through the migration of "surplus" individuals. In this case, the effects would be local and not cumulative. The impacts that changes in fish fauna may have on other elements of the food network, both below and above their trophic level, cannot be predicted based on the current state of knowledge.

4.12.3 Marine mammals

Cumulative impacts on marine mammals, harbour porpoises in particular, can occur mainly due to noise emissions during installation of the deep foundations. Marine mammals can be significantly affected by the fact that – if pile-driving takes place simultaneously at different locations within the EEZ – there is not enough equivalent habitat available to escape and retreat.

Offshore wind farms and platforms have been built relatively slowly and gradually so far. Over a period of seven years, from 2009 up to and including 2018, pile-driving work was carried out in twenty wind farms and on 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 maintained and even lowered through the successful use of noise mitigation systems. Most of the construction sites were 40 to 50 km apart, so that no overlap of noise-intensive pile-driving work occurred that could have resulted in cumulative impacts. Only in the case of the two projects "Seawind South/East" and "North Sea East" in Area 4, which are directly adjacent to each other, was it necessary to coordinate the pile-driving work including the deterrent measures.

The analysis of the results of acoustic tests with respect to noise propagation and the possible resulting accumulation has shown that the dispersion of pulsed sound is greatly limited when effective noise-minimising measures are applied (BRANDT et al. 2018, DÄHNE et al., 2017).

Cumulative impacts of the plan on the harbour porpoise population will be considered in accordance with the requirements of the 2013 noise protection concept of the Federal Minister for the Environment, Nature Conservation, and Nuclear Safety. The main area where the harbour porpoise is concentrated in the summer months is the protected area of the "Sylt Outer Reef" and its indirect surroundings. Pile-driving work with the potential to cause noise disturbances in the main concentration area of the harbour porpoise during the sensitive season must be coordinated in such a way that the proportion of the affected area remains below 1%. In accordance with the noise protection concept of the Federal Minister for the Environment, Nature Conservation, and Nuclear Safety (2013), all pile-driving work is also coordinated with the aim of always keeping sufficient alternative possibilities available in the protected areas, in equivalent habitats and in the entire German EEZ.

4.12.4 Seabirds and resting birds

Vertical structures such as platforms or offshore wind turbines may have different effects on resting birds, such as habitat loss, an increased risk of collision or deterrence and disturbance. These effects are considered under the scope of the environmental impact assessment specific to the location and project, and monitored during the subsequent monitoring of the construction and operation phase of offshore wind farm projects. For resting birds, habitat loss due to cumulative effects of several structures or offshore wind farms can be particularly significant.

Possible effects must be assessed on a species-specific basis in order to assess the significance of cumulative effects on seabirds. In particular, species listed in Annex I of the Wild Birds Directive, species of sub-area II of the "Sylt Outer Reef – Eastern German Bight" nature conservation area and species for which avoidance behaviour with regard to structures has already been established are to be considered with regard to cumulative effects.

When assessing the cumulative effects of implementing offshore wind farms, special consideration must be given to the group of sea divers, which includes the endangered red-throated divers and the black-throated divers, which are also sensitive to disturbances. GARTHE & HÜPPOP (2004) confirm that divers are very sensitive to structures. To assess cumulative effects, both adjacent wind farms and those located in the same contiguous functional spatial unit defined by physically and biologically significant properties for a species must be considered. In addition, the effects of shipping traffic (and for the operation and maintenance of cables and platforms as well) must be included in addition to the structures themselves. Current findings in studies confirm the deterrent effect on divers triggered by ships. The red- and black-throated divers are among the bird species most sensitive to ship traffic in the German North Sea. (MENDEL et al. 2019, FLIESSBACH et al. 2019).

Until 2007, the cumulative effects of offshore wind farms on divers were assessed in the approval practices of the Federal Maritime and Hydrographic Agency on the basis of quantitative criteria and taking into account the existing knowledge at that time. In order to assess the significance of this quantitatively assumed impact and to answer the question as to the existence of the reason for denying the threat to the marine environment, population biological thresholds and a suitable relevant reference value for this threshold were defined. In the literature, it is proposed for birds that an intervention be considered inadmissible if 1% of the biogeographical population is affected by habitat loss. Reference is made to criteria of the 1971 Ramsar Convention on Wetlands of International Importance, according to which a resting area is of international importance if it accommodates at least 1% of the biogeographical population of a waterbird species at least once a year (DIERSCHKE et al. 2003).

This 1% criterion can also be found in the classification of Important Bird Areas (IBA). An area is designated an IBA by Birdlife International if it is home to more than 1% of the biogeographical population (HEATH AND EVANS 2000). However, this 1% Ramsar Convention threshold cannot currently be transferred in terms of population biology for the assessment of the significance of interventions or disturbances (DIERSCHKE et al. 2003). Since the Ramsar Convention uses the 1% criterion to assess the significance of wetlands, the very different intentions mean that it does not appear technically and scientifically justifiable to apply this criterion to the assessment of an intervention.

At the same time, the 1% criterion was regarded as at least suitable for approaching the quantification of an intervention in approval practices until 2007 due to the absence of other reliable criteria. In order to account for the ecological and functional significance of the German EEZ for divers, what is known as the Northwest European winter resting population (NW European winter resting population) was defined as the relevant reference population for the assessment of cumulative effects on divers in consultation with the Federal Agency for Nature Conservation and experts. This population is 110,000 in size (LEOPOLD et al. 1995, SKOV et al. 1995). Applied to the NW European winter resting population, 1% of this population is equivalent to 1,100 individuals.

The addition of the number of affected divers, which was carried out until 2007 as part of the assessment of cumulative effects, also took into account the size of a project area, including a deterrence distance of 2 km.

However, the publication of the results of the operational monitoring of the Danish offshore wind farm "Horn Rev I" in 2006 gave reason to review the assessment of cumulative effects in the light of the new findings. The investigations showed that avoidance effects on divers up to 4 km away from the wind farm were verifiable and significant (PETERSEN et al.2006).

The extensive data available as early as 2007 from German marine areas, consisting of environmental impact studies, research and monitoring, and the findings from the Danish wind farm were evaluated in a scientific study. Based on the new findings of this study, it was possible to identify and delineate a main concentration area for divers in the German North Sea EEZ.

The main concentration area takes into account spring, the most important period for the species. Based on the data available at the time the main concentration area was defined in 2009, the main concentration area was home to about 66% of the German North Sea diver population and about 83% of the EEZ population in spring and is therefore of particular importance in terms of population biology (BMU 2009) and an important functional component of the marine environment in terms of seabirds and resting birds. The importance of the main concentration area for divers in the German North Sea and within the EEZ has increased further against the background of current population calculations (SCHWEMMER et al. 2019). The demarcation of the main concentration area of divers is based on a data availability defined as very good and on technical analyses for which there is broad scientific acceptance. The area includes all regions in the German Bight with very high diver numbers and most of the areas with high diver numbers. The definition of the main concentration area of the divers in the German North Sea EEZ as part of the position paper of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2009) is an important measure to ensure the protection of the species of red- and black-throated divers. The Federal Ministry for the Environment, Nature Conservation, Construction and Nuclear Safety stipulated that in future approval procedures for offshore wind farms the main concentration area should be used as a yardstick for the cumulative assessment of the loss of diver habitat.

Since 2009, the Federal Maritime and Hydrographic Agency has carried out the qualitative assessment of cumulative effects on divers using the main concentration area in accordance with the position paper of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2009) under the scope of approval procedures.

Between 2010 up to and including 2013, a number of approved offshore wind farm projects carried out the third year of the baseline survey as part of implementation. The Federal Agency for Nature Conservation and the Federal Maritime and Hydrographic Agency took the completion of the basic investigations as an opportunity to jointly commission a study to evaluate the findings on the main concentration area, taking into account all data available at that time on the diver population in the German Bight before the start of the construction and operation of offshore wind farms in the German EEZ. The results of the study confirmed the importance and delimitation of the main concentration area of divers in spring (GARTHE et al. 2015).

The current findings from the operational monitoring of offshore wind farms and from research projects, some of which made use of investigation methods independent of standardised monitoring in accordance with the Standard Investigation Concept (StUK) (e.g. telemetry study under the scope of the DIVER project), consistently show that the avoidance behaviour of divers in relation to offshore wind farms is far more pronounced than had been anticipated in the original approval decisions of the wind farm projects (see chapter 4.6.).

The Federal Agency for Nature Conservation and the Federal Maritime and Hydrographic Agency then again commissioned a study under the scope of ongoing research projects to comprehensively and jointly evaluate the extensive data from the operational monitoring of offshore wind farms as well as from research and monitoring of the Natura 2000 sites. The overall goal of the project was to assess the cumulative effects of the operation of the offshore wind farms on the occurrence of divers. Interim results of this Research and Technology Centre study were presented at the Marine Environment Symposium of the Federal Maritime and Hydrographic Agency 2018. The analyses have now been published (GARTHE et al. 2018, SCHWEMMER et al. 2019). The cumulative analysis of the avoidance behaviour of divers in relation to offshore wind farms yielded a calculated total habitat loss of 5.5 km and a statistically significant decrease in abundance up to 10 km away, starting from the periphery of a wind farm (GARTHE et al. 2018). For the statistically significant decrease in abundance, this is not a total avoidance but a partial avoidance with increasing diver densities up to 10 km away from a wind farm. The calculated total habitat loss of 5.5 km is used to quantify the habitat loss, similar to the previous deterrence distance of 2 km. This is subject to the purely statistical assumption that there are no divers up to a distance of 5.5 km from an offshore wind farm.

The current state of knowledge from the above-mentioned study will be taken into account from now on in sectoral planning and in decisions of the Federal Maritime and Hydrographic Agency. The definition of suitable measures will be reviewed in cooperation with the nature conservation authority.

Against this background, based on the calculated total habitat loss of now 5.5 km, 19% of the 7,332 km^2 main concentration area is no longer available for divers due to their avoidance behaviour in relation to the wind farm projects already implemented and analysed in the position paper. Based on the assumptions made in the position paper (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety 2009) of a deterrence distance of 2 km, 9% area loss in the main concentration area was anticipated. This means that already at this point in time, the area-related impairment in this important habitat is greater than originally assumed.

In summary, the results from monitoring and research projects show that the avoidance behaviour of divers in relation to offshore wind farms is much more pronounced than previously assumed. A current population calculation in the main concentration area for the period 2002 to 2012 yielded an increase in the number of red-throated divers, which has remained at a relatively constant high level since 2012. However, a decrease in the red-throated diver population has been recorded since 2012 for the entire German North Sea, the sub-areas of which have different local significance as habitats for divers. These observations illustrate the special functional significance of the main concentration area as a habitat for divers in the German North Sea in view of the pronounced avoidance behaviour and associated habitat loss (SCHWEMMER et al. 2019).

The main concentration area represents a particularly important component of the marine environment with regard to seabirds and resting birds, in particular with regard to the species group of divers. Taking into account the new findings, further cumulative effects on the number of divers can be expected from the implementation of other wind farm projects in the main concentration area. This alone poses a threat to the marine environment pursuant to section 5 subsection 3 WindSeeG, notwithstanding the issue of admissibility under species conservation law. For this reason area N-5.4 may not be designated. Areas N-5 and N-4 were reviewed for subsequent use (see chapters 7.4 and 7.5 of the Site Development Plan). The detailed assessment and justification are explained in chapter 5.2 of the Environmental Report.

4.12.5 Migratory birds

With respect to the cumulative effects on bird migration, it will be investigated whether the planned offshore wind farms, including converter sites, will increase the risk of migratory birds being endangered in conjunction with adjacent wind farms or wind farms on the flight path. All wind farm projects included in the Site Development Plan will have the opportunity to obtain a permit on the basis of forecasts, taking into account the effective impact of requirements and the current state of knowledge. This must be verified in the individual procedure on a project- and site-specific basis.

A potential danger for migratory birds results firstly from the risk of collision with the individual offshore wind turbines or the converter platform and secondly from adverse effects on the energy resources of the birds due to forced changes in the flight route. Under normal migratory conditions preferred by migratory bird species, there is so far no evidence for any species that the birds typically migrate in the danger zone of the turbine and/or do not recognise and avoid these obstacles.

In the clear weather conditions preferred by the birds for migration, the probability of a collision with a wind turbine or converter platform is therefore very low. A potentially dangerous situation is posed by unexpected fog and rain, which lead to poor visibility and low flight altitudes. A particular problem is when bad weather conditions coincide with what are known as mass migration events. This forecast is qualified by more recent research results obtained on the FINO1 research platform. It was found that birds migrate at higher altitudes in very poor visibility (less than 2 km) than in medium visibility (3 to 10 km) or good visibility. (> 10 km, HÜPPOP et al. 2005). However, these results are based on only three nights of measurement.

The risk of collision for migrating birds and seabirds during the day is generally estimated to be low. They orient themselves visually and are usually able to land on water. Studies on lightships in Denmark (HANSEN 1954) have shown that light sources are rarely approached by sea and water birds, but more by small bird species such as song thrushes, starlings and skylarks The risk of bird strikes could therefore be more likely to occur in large songbird populations that migrate at night.

In order to minimise the risk, turbines must be designed so that light emissions are avoided as far as possible during construction and operation, unless they are unavoidable and required by safety requirements for ship and air traffic and occupational safety requirements. Lighting that is as compatible as possible during operation of the converter platform in order to minimise attraction spans measures, e.g. switching obstruction lighting on and off as required, selection of suitable lighting intensities and spectra or lighting intervals.

In addition to the risk of bird strikes, the cumulative impacts of the converter platforms planned in the Site Development Plan and the wind farms included could also result in a longer migratory route. If migratory birds fly within the range of influence of wind turbines and converter platforms (up to a height of approx. 200 m), they are forced to fly around or over the turbines through evasive movements. They are thus diverted to a greater or lesser extent from their migration route. It is a known fact that wind farms are avoided by birds, i.e. they fly around or over them. This behaviour has been seen not only on land but also offshore (e.g. KAHLERT et al. 2004, AVITEC RESEARCH GBR 2015, BIOCONSULT SH 2017a). Lateral avoidance reactions appear to be the most common reaction (HORCH & KELLER 2004).

The potential impairment to bird migration as a barrier depends on many factors, in particular the orientation of the wind farms to the main migration directions. Based on the current state of knowledge, birds that migrate at night migrate mainly from southwest to northeast across the North Sea in a broad front. Assuming the main migration direction is southwest to northeast and vice versa, the wind farms in the same or another area adjacent to each other in this direction form a uniform barrier, so that a single evasive movement is sufficient. It is therefore not expected that the additional energy required for a possible detour would endanger bird migration due to a possibly necessary detour as weather conditions can also lead to diversions.

This is also confirmed by the results of a F&E project to develop suitable analysis and evaluation methods of cumulative impacts of offshore wind turbines on bird migration (HÜPPOP et al. 2005a). On the basis of thirteen mainly nocturnally migrating songbird species, including short-, medium- and long-distance migratory species, HÜPPOP et al. (2005a) investigated the conditional conditions under which they cross the German Bight. The results show that short- to medium-distance migratory species have on average lower body reserves and are therefore probably more affected by potential barriers than species that migrate over long distances. The authors calculated a loss of body reserves for a migration route over sea extended by approx. 110 km due to barriers (with no wind), which could result in a lower reproductive performance in the absence of compensation (additional rest of 1 to 2 days). There is no discussion of an increase in the mortality rate of migrating birds themselves.

An analysis of the existing findings on the migratory behaviour of the various bird species, the usual flight altitudes and the daily distribution of bird migration leads to the conclusion that, based on the current state of knowledge, it is unlikely that bird migration will be endangered by the construction and operation of the planned offshore wind farms <u>under cumulative consideration of the already approved offshore wind farm projects</u>. At present, no significant negative effect on the further development of the populations can be expected from possibly flying around the turbines.

It must be borne in mind that, based on the current state of science and technology, this forecast is based on premises that are not yet suitable to adequately secure the basis for the factor. Insufficient knowledge exists particularly about species-specific migration patterns. This applies, in particular, to bad weather conditions (rain, fog). These gaps in knowledge could not be filled despite extensive research activities conducted as part of the ecological support research on the test field "alpha ventus" (Test field research on bird migration at the offshore pilot farm "alpha ventus" (contract number: 0327689A/Avitec1), evaluation of the data collected continuously on FINO1 (2008-2011) (0327689A/Avitec2), recording of bird collisions using the VARS system (0327689A/IfAÖ1) and recording of evasive movements of migratory birds using Pencil Beam Radar (0327689A/IfAÖ2)).

4.13 Transboundary impacts

The SEA comes to the conclusion that as things stand at present, the specifications in the Site Development Plan have no significant effects on the areas of neighbouring states bordering on the German EEZ in the North Sea.

Substantial transboundary impacts can generally be excluded for the factors Landscape, Cultural heritage and Other material assets and Human beings and Human health. Possible substantial transboundary impacts could only arise if considered cumulatively, including all planned wind farm projects in the area of the German North Sea, for the highly mobile factors Fish, Marine mammals, Seabirds and resting birds, as well as Migratory birds and Bats.

The SEA comes to the conclusion that, according to the current state of knowledge, the implementation of the Site Development Plan is not expected to have any substantial transboundary impacts on the factor Fish, since on the one hand the areas for which the Site Development Plan defines rules have no prominent function for fish fauna, and on the other the discernible and predictable effects are small-scale and temporary in nature. According to current knowledge and taking into account measures to minimise impact and limit damage, substantial transboundary impacts can also be ruled out for the factor Marine mammals. The installation of the foundations of wind turbines and converter platforms, for example, is only permitted in the specific approval procedure if effective noise mitigation measures are taken (see 4.4.1.7 Site Development Plan). For the factor Seabirds and resting birds, the Danish bird sanctuary "Sydlige Nordsø", which is directly adjacent to the German EEZ to the north and also has a high number of divers, has to be taken into account when considering possible significant transboundary impacts. The non-designation of area N-5.4 counteracts a possible impairment of the Danish bird sanctuary, including the presence of sea divers there.

For migratory birds, the wind turbines and platforms erected in Site Development Plan sites may constitute a barrier or present a risk of collision. As the platforms are individual structures in the immediate vicinity of offshore wind farms, however, no significant impairment of bird migration due to platforms alone is to be expected. When considering the collision risk posed by wind turbines, the already existing development of some areas must be taken into account in connection with future developments involving new turbine types of larger dimensions. The collision risk must therefore be assessed differently for each specific area. However, final cumulative consideration of the effects on bird migration, including all offshore wind farms to be taken into account, is currently not possible due to a lack of knowledge of the actual collision risk.

5 Assessment of wildlife conservation regulations

According to section 37 of the Federal Nature Conservation Act, general wildlife conservation generally includes

- protection of wild species of fauna and flora and their communities from human interference, and safeguarding of their other living conditions,
- protection of habitats and biotopes of wild animal and plant species, and
- reintroduction of fauna and flora of displaced wild species in suitable biotopes within their natural distribution area.

Special provisions with prohibitions are applicable to fauna of specially or strictly protected species. Wild animals of specially protected species may not be injured or killed according to section 44 subsection 1 of the Federal Nature Conservation Act. Pursuant to section 44 subsection 1 no. 2 of the Federal Nature Conservation Act, wild animals of strictly protected species and of European bird species may not be significantly disturbed during their breeding, rearing, moulting, hibernation and migration periods. Significant disturbance occurs when the conservation status of the local population of a species deteriorates as a result of the disturbance.

It does not matter whether a relevant injury or disturbance is due to reasonable grounds; nor do reasons, motives or subjective tendencies play any part in respect of compliance with the prohibitions (LANDMANN/ROHMER, 2018).

This species conservation assessment investigates whether the Site Development Plan fulfils the requirements of section 44 subsection 1 no. 1 and no. 2 of the Federal Nature Conservation Act for specially protected species. It will examine in particular whether the plan violates prohibitions under wildlife conservation regulations. This assessment of wildlife conservation regulations takes place at the primary level of the sectoral plan. A detailed assessment of wildlife conservation regulations for the individual sites and projects must be carried out as part of the assessment of the suitability of specific sites or the individual approval procedure in question.

5.1 Marine mammals

The harbour porpoise, harbour seal and grey seal, which are species listed in Annex II (animal and plant species of Community interest whose conservation requires designation of special areas of conservation) and Annex IV (animal and plant species of Community interest in need of strict protection) of the Habitats Directive and are to be protected in accordance with Art. 12 of the Habitats Directive, occur in the German EEZ of the North Sea. Harbour porpoises occur in different densities all year round depending on the area. This also applies to harbour seals and grey seals. It can generally be assumed that harbour porpoises cross and stay in the entire German EEZ of the North Sea and, to some extent, also use it as feeding and rearing grounds. On the basis of available findings, it is possible to derive the importance of the different areas for harbour porpoises.

Use varies significantly in the individual areas. Areas N-1, N-2 and N-3 are of medium to high importance for harbour porpoises (seasonal in spring) and of low to medium importance for grey seals and harbour seals. Areas N-6 to N-10 and N-12 are of medium importance for harbour porpoises and of low importance for grey seals and harbour seals. The sub-sites of area N5 are located in a large area which is used both as a feeding and rearing ground for harbour porpoises – even if the focus of concentration is within area I of the "Sylt Outer Reef – Eastern German Bight" nature conservation area. It is generally assumed that areas N-4 and N-5, and in some cases areas N-11 and N-13, are of high importance for harbour porpoises. Areas N-4 and N-5 are of low to medium importance for grey seals and harbour seals. Areas N-11 and N-13 are of low importance for grey seals and harbour seals.

5.1.1 Section 44 subsection 1 no. 1 of the Federal Nature Conservation Act (prohibition of injury and killing)

According to section 44 subsection. 1 no. 1 of the Federal Nature Conservation Act, the killing or injury of wild animals of specially protected species, i.e. animals listed in Annex IV of the Habitats Directive, is prohibited. The species conservation assessment pursuant to section 44 subsection 1 no. 1 of the Federal Nature Conservation Act relates to the killing and injury of individuals and is therefore carried out uniformly for all areas of the plan N-1 up to and including N-13.

5.1.1.1 Areas and sites for offshore wind turbines

Pursuant to section 44 subsection 1 no. 1 of the Federal Nature Conservation Act, which is to be interpreted in light of Art. 12 (1a) of the Habitats Directive, the killing or injury of wild animals of specially protected species, i.e. animals listed in Annex IV of the Habitats Directive, is prohibited. The Federal Agency for Nature Conservation regularly assumes in its comments that, according to the current state of knowledge, porpoises suffer injuries in the form of temporary hearing loss when exposed to a single event sound pressure level (SEL) of 164 dB re 1 µPa^{2}Hz or a peak level of 200 dB re 1 µPa.

According to the Federal Agency for Nature Conservation, based on the current state of knowledge, it can be assured with sufficient certainty that if the specified limit values of 160 dB for the sound event level (SEL_{05}) and 190 dB for the peak level at a distance of 750 m from the emission site are complied with, the prohibition of killing and injury as defined in section 44 subsection 1 no. 1 of the Federal Nature Conservation Act is not violated for the harbour porpoise.

The Federal Agency for Nature Conservation takes into account the currently common use of monopiles with diameters of up to 8.2 m for wind turbines and jacket piles with diameters of up to 4 m for transformers. The Federal Agency for Nature Conservation assumes that suitable means such as deterrence, soft-start procedure etc. are used to ensure that no harbour porpoises are present within the 750 m radius around the pile-driving location.

The Federal Maritime and Hydrographic Agency agrees with this assessment.

In addition, the Federal Maritime and Hydrographic Agency imposes a series of noise protection measures under the scope of the planning approval and implementation. These measures are designed to rule out the possibility of the prohibition being violated or to reduce the intensity of any impairments (known as conflict avoidance or mitigation measures), see inter alia *Lau* in: Frenz/Müggenborg, Federal Nature Conservation Act, comment, Berlin 2011, section 44 marg. no. 3. The measures are strictly monitored in order to ensure with the necessary certainty that the prohibition of killing and injury as defined in section 44 subsection 1 no. 1 of the Federal Nature Conservation Act is not violated.

In order to ensure with the necessary certainty that the prohibition of killing and injury as defined in section 44 subsection 1 no. 1 of the Federal Nature Conservation Act is not violated, the Federal Maritime and Hydrographic Agency prescribes suitable deterrent measures and a slow increase in pile-driving energy, known as "soft starts", under the scope of individual planning approval decisions as well as under the scope of implementation. The prescribed deterrence measures and "soft starts" ensure that no harbour porpoises or other marine mammals are present in an adequate area around the pile/driving site, but at least up to 750 m from the construction site. Until 2017, a combination of pingers was used as a pre-warning system followed by the use of the so-called seal scarers for the purpose of deterrence. However, deterrence using seal scarers is associated with a large habitat loss caused by the flight responses of the animals and therefore represents a disturbance (BRANDT et al., 2013). The development of new systems, such as the FaunaGuard system, creates the possibility of adapting deterrence of harbour porpoises and seals in such a way that the possibility that the prohibition of killing and injury as defined in section 44 subsection 1 no. 1 of the Federal Nature Conservation Act being violated can be ruled out with certainty without simultaneously violating the prohibition of disturbance as defined in section 44 subsection 1 no. 2 of the Federal Nature Conservation Act.

Since 2018, the FaunaGuard system is used as a deterrence measure in all construction projects in the German EEZ of the North Sea. The use of the FaunaGuard system is accompanied by strict monitoring measures with good results. Within the scope of a research project, the effects of the FaunaGuard system are to be systematically analysed and, if necessary, the application of the system for future construction projects optimised.

In addition, the required degree of noise mitigation is such that it can be assumed that no deadly or long-term adverse effects will occur outside the area where no harbour porpoises can be expected due to the deterrent measures to be implemented.

The measures prescribed by the Federal Maritime and Hydrographic Agency will prevent with sufficient certainty any violation of the prohibition under species conservation law as defined in section 44 subsection 1 no. 1 of the Federal Nature Conservation Act.

5.1.1.2 Platforms

The platforms are currently being installed with pile-driven deep foundations on a regular basis. Creating foundations using alternative methods, such as gravity foundations, is currently the exception. With regard to the possible effects of pile-driving on marine mammals, the information provided under "Areas and sites for wind energy" for the construction of wind turbines applies.

Without the use of effective noise-minimising and damage-limiting measures, the possibility of marine mammals being impaired during the installation of the foundations cannot be ruled out. The planning principle for noise mitigation in the Site Development Plan therefore also applies to platforms without restriction.

For this reason, the environmental impact assessment is carried out on the condition that noise mitigation measures are used to comply with the applicable noise protection values. For the construction of platforms with driven-in piles, all measures apply, as explained under "Areas and sites for wind energy".

The Federal Maritime and Hydrographic Agency assumes that if the specified noise protection values for the sound event level of 160 dB re 1µPa²s and 190 dB re 1µPA for the maximum peak level at a distance of 750 m from the sound source are complied with and deterrence measures and what are known as "soft starts" are used, according to the current state of knowledge, it can be guaranteed with sufficient certainty that the prohibition of killing and injury in relation to harbour porpoises and seals is not violated as defined section 44 subsection 1 no. 1 of the Federal Nature Conservation Act. This applies to all areas analysed.

5.1.1.3 Submarine cabling systems

Based on the current state of knowledge, the laying and operation of submarine cable systems will not have any significant negative impacts on marine mammals that violate the prohibition of killing and injury as defined in section 44 subsection 1 no.1 of the Federal Nature Conservation Act.

5.1.2 Section 44 subsection 1 no. 2 of the Federal Nature Conservation Act (prohibition of disturbance)

According to section 44 subsection 1 no. 2 of the Federal Nature Conservation Act it is also prohibited to significantly disturb wild animals of strictly protected species during their breeding, rearing, moulting, hibernation and migration periods, whereby a disturbance shall be deemed significant if it causes the conservation status of the local population of a species to worsen.

The harbour porpoise is a strictly protected species in accordance with Annex IV of the Habitats Directive and thus within the meaning of section 44 subsection 1 no. 2 of the Federal Nature Conservation Act, so that a species conservation assessment must also be conducted in this respect.

The species conservation assessment pursuant to section 44 subsection 1 no. 2 of the Federal Nature Conservation Act refers to population-relevant disturbances of local stocks, the occurrence of which varies in the areas covered by the plan. The results of the species conservation assessment are therefore subsequently represented for individual areas or groups of areas with comparable occurrences.

5.1.2.1 Areas and sites for offshore wind energy

The Federal Agency for Nature Conservation assesses in its comments whether a disturbance as defined in section 44 subsection 1 no. 2 of the Federal Nature Conservation Act exists under the scope of planning approval and implementation procedures. It concludes that the occurrence of a significant disturbance caused by underwater noise due to construction can be avoided for the factor Harbour porpoise provided that the noise event level of 160 dB or the peak level of 190 dB is not exceeded at a distance of 750 m from the emission point and sufficient alternative areas are available in the German North Sea According to the Federal Agency for Nature Conservation's stipulation, the latter is to be ensured by coordinating the timing of noise-intensive activities of various project developers with the aim that no more than 10% of the area of the German EEZ in the North Sea is affected by disturbance-triggering noise (noise protection concept of the Federal Minister for the Environment, Nature Conservation, and Nuclear Safety, Dec. 2013).

The species conservation assessment is based on the following considerations:

According to Art. 12 (1b) Habitats Directive in conjunction with section 44 subsection 1 no. 2 of the Federal Nature Conservation Act any intentional disturbance of these species, particularly during their breeding, rearing, hibernation and migration periods, is prohibited. According to section 44 subsection 1 no. 2 of the Federal Nature Conservation Act it is prohibited to disturb wild animals of strictly protected species, i.e. animals listed in Annex IV of the Habitats Directive, among others, during breeding, rearing, hibernation and migration periods.

According to the legal definition found in section 44 subsection 1 no. 2, 2nd clause of the Federal Nature Conservation Act, a disturbance shall be deemed significant if it causes the conservation status of the local population of a species to worsen. According to the guidelines on the strict protection system for species of Community interest under the Habitats Directive (marg. no. 39) a disturbance as defined in Art. 12 of the Habitats Directive is deemed to exist if the action in question reduces the chances of survival, reproductive success or reproductive capacity of a protected species or if this action leads to a reduction in its distribution range On the other hand, occasional disturbances without foreseeable negative impacts on the species in question are not to be regarded as disturbances within the meaning of Art. 12 of the Habitats Directive.

Possible impacts of pile-driving work during the construction phase of offshore wind farms on harbour porpoises:

The existence of a disturbance as defined in Art. 12 (1b) of the Habitats Directive in conjunction with section 44 subsection 1 no. 2 of the Federal Nature Conservation Act for the harbour porpoises cannot be assumed during the temporary pile-driving work.

Based on the current state of knowledge, it cannot be assumed that disturbances potentially resulting from noise-intensive construction measures would worsen the conservation status of the "local population".

Effective noise protection management, in particular if suitable noise mitigation systems are used as stipulated in the Federal Maritime and Hydrographic Agency's planning and approval decisions and the requirements of the noise protection concept of the Federal Minister for the Environment, Nature Conservation, and Nuclear Safety (2013) are taken into account, means that negative impacts of the pile-driving work on harbour porpoises are not to be expected.

The planning approval decisions of the Federal Maritime and Hydrographic Agency therefore contain provisions which ensure effective noise protection management by means of suitable measures.

In accordance with the precautionary principle, measures to prevent and reduce the impacts of noise during construction must be defined in accordance with the latest scientific and technical knowledge. The measures required in the planning approval decisions to guarantee the requirements of species protection will be coordinated with the Federal Maritime and Hydrographic Agency over the course of implementation. Noise reduction and environmental protection measures include:

- Creation of a concrete noise report taking into account the site- and turbine-specific properties (basic design) before the start of construction
- Selection of a construction method that is as quiet as possible in line with state-of-the-art technology
- Creation of a concrete noise protection concept, adapted to the selected foundation structures and construction processes, to carry out the pile-driving work
- Taking into account noise reduction support measures in line with the current state of science and technology
- Taking into account the properties of the hammer and the options for managing the pile-driving process
- Concept for deterring animals from the hazardous zone (a radius of at least 750 m around the pile-driving location)
- Concept to assess the efficiency of the deterrence and noise reduction measures
- Turbine designed to minimise operational noise in line with the current state of technology

Deterrent measures and a "soft start" are to be used to ensure that animals present in the vicinity of the pile-driving work have the opportunity to leave the area or move away in due time Since 2018, a new system, the FaunaGuard system, has been used in construction projects in the German North Sea EEZ to deter animals from the hazardous zone of construction sites. The newly optimised FaunaGuard deterrence system has the advantage over the seal scarers system used up to and including 2017 of effectively driving the animals out of the hazardous zone without causing a disturbance through large-scale displacement of the animals out of the habitat.

The selection of noise mitigation measures must be based on state-of-the-art science and technology and on experience already gained in other offshore projects. Practical knowledge on the application of technical noise mitigation measures as well as experiences with management of the pile-driving process in connection with the properties of the impulse hammer were gained in particular during the foundation work in the projects "Butendiek", "Borkum Reef Ground I", "Sandbank", "Gode Wind 01/02", "North Sea One", "Veja Mate", "Arkona Basin Southeast", "Merkur Offshore" as well as from ongoing construction projects.

In addition, monitoring measures and noise measurements are stipulated in the planning approval decisions in order to record any potential on-site dangers and, if necessary, to initiate damage-limiting measures. Overall, to the best of our knowledge, the impact of the pile-driving operations on the harbour porpoise population in the North Sea can be ruled out with sufficient certainty.

New findings confirm that the reduction of noise emissions through the use of technical noise mitigation systems clearly reduces disturbances for harbour porpoises. Minimising effects involves the spatial as well as the temporal scope of disturbances. (BRANDT et al. 2016).

The Federal Maritime and Hydrographic Agency concludes that if strict noise protection and noise mitigation measures are implemented in accordance with the planning approval decisions and the noise limit of 160 dB SEL_5 is observed at a distance of 750 m, considerable disturbances as defined in section 44 subsection 1 no. 2 of the Federal Nature Conservation Act are not to be expected. Furthermore, the Federal Agency for Nature Conservation's requirement to coordinate the timing of noise-intensive construction phases of various project developers in the German North Sea EEZ remains.

Possible impacts of <u>operation</u> of the offshore wind farm on harbour porpoises:

The existence of a disturbance as defined in Art. 12 (1b) of the Habitats Directive in conjunction with section 44 subsection 1 no. 2 of the Federal Nature Conservation Act caused by <u>operation</u> of offshore wind turbines can also not be assumed based on the current state of knowledge. Based on the current state of knowledge, no negative long-term effects are to be expected from the noise immissions of the turbines for harbour porpoises, even in the design of the turbines. Any impacts are limited to the immediate vicinity of the turbine and depend on the noise distribution in the specific area and not least on the presence of other noise sources and background noise, such as shipping traffic (MADSEN et al. 2006). There are also recent findings available from experimental work on the detection of low-frequency acoustic signals by harbour porpoises with the aid of simulated operating noises from offshore wind energy-turbines (LUCKE et al. 2007b). Masking effects were recorded for simulated operating noises of 128 dB re 1 µPa at frequencies of 0.7, 1.0 and 2.0 kHz. In contrast, no significant masking effects were observed for operating noises of 115 dB re 1 µPa. The initial results thus indicate that only masking effects are to be expected from operating noises, depending on the type of turbine or intensity of the operating noises and only in the immediate vicinity of the respective turbine.

A study conducted on the Dutch offshore wind farm "Egmont aan Zee" provides findings on the habitat use of offshore wind farms by harbour porpoises during operation. With the aid of acoustic recording, the use of the site of the wind farm or of two reference sites by harbour porpoises was investigated before the construction of the turbines (baseline survey) and in two consecutive years of the operating phase. The results of the study confirm a pronounced and statistically significant increase in acoustic activity in the inner area of the wind farm during the operating phase compared to activity or use during baseline survey (SCHEIDAT et al. 2011). The increase in harbour porpoise activity within the wind farm during operation significantly exceeded the increase in activity in both reference areas. The increase in use of the area of the wind farm was clearly independent of seasonality and interannual variability. The authors of the study see a direct correlation between the presence of the turbines and the increased use by harbour porpoises. They suspect the causes to lie in factors such as the increase in the food supply by what is known as the "reef effect" or the calm waters in the area due to the absence of fishing and shipping, or possibly a positive combination of these factors.

The results from the investigations in the operating phase of the "alpha ventus" project also suggest a return to distribution patterns and abundances of the harbour porpoise, which are comparable – and in some cases higher – to those in the baseline survey of 2008. In addition, further results from offshore wind farms with a large number of wind turbines must be obtained in order to arrive at a final assessment of the possible effects of operation.

In order to ensure with sufficient certainty that the prohibition of disturbance as defined in section 44 subsection 1 no. 2 of the Federal Nature Conservation Act is not violated, a turbine design that uses state-of-the-art technology to minimise operating noise must be guaranteed against this background in accordance with the provision in section 4.1.

Suitable monitoring is obligatory in the operating phase of the individual project in order to be able to record and assess any site- and project-specific impacts).

As a result, the prescribed mitigation measures are sufficient to ensure that, in relation to harbour porpoises, the operation of the wind farm does not violate the prohibition as defined in section 44 subsection 1 no. 2 of the Federal Nature Conservation Act.

Other marine mammals

The detailed considerations for harbour porpoises regarding noise emissions caused by construction and operation activities of offshore wind turbines generally apply to all marine mammals otherwise present in the planning area. However, the hearing levels, sensitivity and behavioural reactions among marine mammals vary considerably depending on the species. The differences in detection and evaluation of sound events among marine mammals are based on two components: first, the sensory systems are morphoanatomically and functionally different depending on the species. As a result, marine mammal species hear and react differently to noise. Second, both detection and reaction behaviour depend on the respective habitat (KETTEN 2004).

Seals are generally considered to be tolerant of noise, especially when food is abundant. However, telemetric investigations have found flight responses during seismic activities (RICHARDSON 2004). According to all previous findings, seals can still hear pile-driving noises at a distance of more than 100 km. Operating noises of 1.5 - 2 MW wind turbines can still be heard by seals 5 to 10 km away (LUCKE K., J. SUNDERMEYER & U. SIEBERT, 2006, MINOSplus Status Seminar, Stralsund, Sept. 2006, presentation).

Assessment of the individual areas:

Areas N-1, N-2 and N-3

The section where areas N-1, N-2 and N-3 are located is used by harbour porpoises as a transit area and feeding ground. Based on the current state of knowledge, these areas lie outside the main concentration area of the porpoise identified in the German Bight in the summer months and have no particular reproductive or rearing function for the harbour porpoise. According to current findings from monitoring the

Natura 2000 sites, it is clear that the area north of the East Frisian islands, between the traffic separation areas and even the "Borkum Reef Ground" nature conservation area have overall densities that are much lower than in sub-area I of the "Sylt Outer Reef – Eastern German Bight" nature conservation area or in the main concentration area of the harbour porpoise in the summer months in the German Bight. A special function as reproductive and rearing area has not been ascertained to date. However, in the years from 2013 onwards, higher densities have been observed in the summer months and thus mother-calf pairs have been seen more frequently than in earlier periods (Monitoring Report 2009-2010 des Research and Technology Centre, West Coast and the German Oceanographic Museum - Marine mammals and seabirds in the German EEZ of the North and Baltic Seas- *Sub-report on marine mammals* –Federal Agency for Nature Conservation, July 2010, Monitoring of marine mammals 2014 in the German EEZ of the North and Baltic Seas, Federal Agency for Nature Conservation, July 2015).

Areas N-1, N-2 and N-3 have no special importance for harbour and grey seals. The nearest frequently used breeding and resting sites are more than 60 km from Helgoland and more than 30 km from the East Frisian islands.

Taking into account the proposed noise mitigation measures, the possibility of the prohibitions pursuant to section 44 subsection 1 no. 1 and no. 2 of the Federal Nature Conservation Act being violated for harbour porpoises and seals can therefore be ruled out with the necessary certainty.

Area N-4

Area N-4 boundaries on sub-area I of the "Sylt Outer Reef – Eastern German Bight" nature conservation area.

The long-term data series from the EIAs and from monitoring of the three offshore wind farms being constructed and operated in this area show that this area is always the lower boundary of the main distribution area of the harbour porpoise in the German Bight during the summer months. After a reduction of the densities during the construction of the WTG, the occurrence has verifiably achieved the monitoring results of the usual densities for the area.

In addition to complying with the noise protection limit, noise-intensive work must also be coordinated in area N-4 during construction of the turbines so that the noise emissions in the nature conservation area is always less than 1% of the area pursuant to the noise protection concept of the Federal Minister for the Environment, Nature Conservation, and Nuclear Safety (2013).

Area N-4 already has structures except for the site of the "KASKASI" project.

Based on the current state of knowledge and taking into account the proposed noise mitigation measures in the construction of the foundations for the "KASKASI" project, the possibility of the prohibitions pursuant to section 44 subsection 1 no. 1 and no. 2 of the Federal Nature Conservation Act being violated for harbour porpoises and seals can therefore be ruled out with the necessary certainty.

Area N-5

The sub-sites of area N-5 lie within the main distribution area of the harbour porpoise during the summer months in the German EEZ of the North Sea.

In all sub-areas, significant numbers of mother-calf pairs occur during the summer months. Area N-5 is very important for harbour porpoises, particularly due to its rearing function. Area N5 is of medium importance for grey and harbour seals.

Based on the current state of knowledge, the possibility of the prohibitions pursuant to section 44 subsection 1 no. 1 and no. 2 of the Federal Nature Conservation Act being violated for harbour porpoises and seals can therefore only be ruled out with the necessary certainty if the proposed noise minimising measures are taken into account and if the requirements outlined in the noise protection concept of the Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (2013) are complied with regard to the exclusion of pile-driving work in the time sensitive for harbour porpoises and noise emissions of less than 1% of the area of sub-area I of the "Sylt Outer Reef – Eastern German Bight".

Areas N-6 to N-10 and N-12

Based on the current state of knowledge, areas N-6, N-10 and N-12 are of medium importance for harbour porpoises and are of low or no importance for grey and harbour seals.

Based on the current state of knowledge and taking into account the proposed noise mitigation measures, the possibility of the prohibitions pursuant to section 44 subsection 1 no. 1 and no. 2 of the Federal Nature Conservation Act being violated for harbour porpoises and seals can be ruled out with the necessary certainty.

Areas N-11 and N-13

Areas N-11 and N-13 extend east of the main distribution area of the harbour porpoise in the German North Sea EEZ. However, the densities found show a gradient with increasing densities east of the areas N-11 and N-13 and within sub-site I of the "Sylt Outer Reef – Eastern German Bight" nature conservation area. Based on the current state of knowledge, Areas N-11 and N-13 are of medium to seasonal importance for harbour porpoises. For grey and harbour seals, areas N-11 and N-13 are of little importance due to their distance from the colonies.

Based on the current state of knowledge and taking into account the proposed noise mitigation measures, the possibility of the prohibitions pursuant to section 44 subsection 1 no. 1 and no. 2 of the Federal Nature Conservation Act being violated for harbour porpoises and seals can be ruled out with the necessary certainty.

5.1.2.2 Platforms

Subject to the use of effective noise mitigation measures in the concrete project to comply with specified noise mitigation values in accordance with the planning principle for noise mitigation and applying the requirements outlined in the noise protection concept of the Federal Minister for the Environment, Nature Conservation, and Nuclear Safety, there is no reason to worry that the installation of the platform foundations will cause disturbance of harbour porpoises in terms of species protection law as defined in section 44 subsection 1 no. 2 of the Federal Nature Conservation Act. The conservation status of the local harbour porpoise populations is not expected to worsen.

In addition to the results of the species conservation assessment for offshore wind farms, the following considerations apply to platforms:

Installing converter platforms is a process with a very limited time frame. The effective time for pile-driving (including deterrence) to be adhered to in each case is specified for each site and turbine in the approval procedure. Within the scope of implementation, coordination of noise-intensive work with other construction projects is required to ensure that sufficient alternative areas are available for the populations of harbour porpoises in the German EEZ. In December 2013, the Federal Minister for the Environment, Nature Conservation, and Nuclear Safety also published a noise protection concept for the protection of the harbour porpoise. The Ministry's noise protection concept pursues an area-related approach with the aim of keeping sufficiently high-quality habitats for harbour porpoises free from areas with noise-intensive pile-driving work by suitable coordination of the construction projects (Federal Ministry for the

Environment, Nature Conservation and Nuclear Safety 2013).

Based on the current state of knowledge, it can be assumed that the installation of piles for pile-driven platforms, taking into account strict noise mitigation measures and accompanied by intensive monitoring measures, will not cause any disturbance relevant under species protection law in accordance with section 44 subsection 1 no. 2 of the Federal Nature Conservation Act.

Any significant effects on harbour porpoises caused by platform operation can be ruled out based on the current state of knowledge. The investigations into the operating noise of the wind turbines in the "alpha ventus" test field have shown that the operational noise levels hardly differ from the background noise at distances of just a few hundred metres (BETKE et al. 2012). The results support the assumption that at a distance of 1000 m from the wind turbine the noise level is 12 to 15 dB below the hearing level of the porpoise. Based on the current state of knowledge, at most comparable noise levels can be expected from platform operation. However, in accordance with the established approval practices, it is also stipulated for the converter platforms that only state-of-the-art technology is to be used that ensures the lowest possible noise emissions in the water body.

5.1.2.3 Submarine cabling systems

Based on the current state of knowledge, the laying and operation of submarine cable systems will not involve any disturbances of marine mammals relevant to species conservation law as defined in section 44 subsection 1 no. 2 of the Federal Nature Conservation Act.

5.2 Avifauna (seabirds, resting birds and migratory birds)

The plan must be evaluated on the basis of species conservation regulations in accordance with section 44 of the Federal Nature Conservation Act in conjunction with Art. 5 of the Wild Birds Directive for avifauna (resting and migratory birds).

Protected bird species listed in Annex I of the Wild Birds Directive occur in varying densities in the vicinity of the planned areas for offshore wind farms and converter platforms as well as along the planned submarine cable routes. Against this background, the compatibility of the plans with section 44 subsection 1 no. 1 of the Federal Nature Conservation Act (prohibition of killing and injury) and section 44 subsection 1 no. 2 of the Federal Nature Conservation Act (disturbance of strictly protected species and European bird species) must be assessed and ensured.

All the information available to date indicates that areas N-1, N-2 and N-3 are of medium importance for seabirds, including species listed in Annex I of the Birds Directive. Area N-4 is actually only of medium importance for most seabird species, however, divers occur there in large numbers in spring. Due to its location within the main concentration area of divers, area N-4 is of great importance. Area N-5 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 strictly protected divers. Area N-5 and its surroundings have a high occurrence of seabird species, in particular protected species listed in Annex I to the Wild Birds Directive, such as the divers, which are sensitive to disturbances. Areas N-6 to N-13 lie outside the concentration centres of various species of birds listed in Annex I of the Wild Birds Directive, such as divers, terns, little gulls and common gulls.

In addition, parts of the EEZ are of average to above-average importance for bird migration. It is assumed that considerable numbers of songbirds breeding in Northern Europe migrate across the North Sea. However, there are no leading lines or concentration ranges for bird migration in the EEZ. There are indications that the migration intensity decreases with the distance to the coast, but this is not clear for the mass of nocturnally migrating songbirds.

5.2.1 Section 44 subsection 1 no. 1 of the Federal Nature Conservation Act (prohibition of injury and killing)

The species conservation assessment pursuant to section 44 subsection 1 no. 1 of the Federal Nature Conservation Act relates to the killing and injury of individuals and is therefore carried out uniformly for all areas of the plan N-1 up to and including N-13.

5.2.1.1 Areas and sites for offshore wind turbines

Pursuant to section 44 subsection 1 no. 1 of the Federal Nature Conservation Act in conjunction with Art. 5 of the Wild Birds Directive, it is prohibited to hunt, catch, injure or kill wild animals of specially protected species. Specially protected species include the species listed in Annex I to the Wild Bird Directive, species whose habitats and environments are protected in nature conservation areas and characteristic species of the areas covered by the plan. Accordingly, the possibility of any injury or killing of resting birds as a result of collisions with wind turbines must be ruled out. The risk of collision depends on the behaviour of the individual birds and is directly related to the species in question and the environmental conditions. For example, divers are unlikely to collide due to their pronounced avoidance behaviour towards vertical obstacles.

When planning and approving public infrastructure and private construction projects, it must be assumed that unavoidable killings or injuries of individuals for operational reasons (e.g. through collision of bats or birds with wind turbines) are not covered by the prohibition as socially adequate risks (Bundestag Printed Paper 16/5100, p. 11 and 16/12274, p. 70 f.). They are only attributed if the risk of success for the project increases significantly due to special circumstances, such as the construction of the turbines, the topographical conditions or the biology of the species. Risk avoidance and mitigation measures are to be included in the assessment; see Lütkes/Ewer/Heugel, section 44 of the Federal Nature Conservation Act, marg. no. 8, 2011; Federal Administrative Court (BVerwG), ruling from 12 March 2008; Ref. no. 9 A3.06; Federal Administrative Court (BVerwG), ruling from 09. July 2008, ref. no. 9 A14.07; Frenz/Müggenborg/Lau, section 44 of the Federal Nature Conservation Act, marg. no. 14, 2011.

The Federal Agency for Nature Conservation regularly states in its comments that, due to changes in the technical size parameters of the wind turbines in current projects, the vertical obstacles in the airspace are generally increased compared to farms constructed from 2011 to 2014. However, based on the current state of knowledge, an increased risk of bird strikes cannot be quantified by simultaneously reducing the number of turbines. Although collision-related individual losses due to the construction of a stationary system in previously unobstructed spaces cannot be completely ruled out, the prescribed measures, such as minimising light emissions, ensure that collisions with offshore wind turbines are avoided as far as possible or at least that this risk is minimised. In addition, monitoring is carried out during the operating phase to improve the nature conservation assessment of the actual risk of bird strikes posed by the turbines. The right to prescribe additional measures is also explicitly reserved. Against this background, the Federal Maritime and Hydrographic Agency does not expect any significant increase in the risk of killing or injuring migratory birds. Consequently, the plan does not violate the prohibition of killing and injury pursuant to section 44 subsection 1 no. 1 of the Federal Nature Conservation Act.

The Federal Agency for Nature Conservation comes to the same conclusion in its comments.

Based on the current state of knowledge, there is no evidence of a significantly increased risk of a site-related collision of individual species of resting birds in Areas N-1 to N-13 of the plan.

Therefore, it cannot be assumed that the prohibition of injury and killing will be realised in accordance with section 44 subsection 1 no. 1 of the Federal Nature Conservation Act.

5.2.1.2 Platforms

Collisions with converter platforms may result in the death or injury of birds. It can be assumed that the species affected will mainly be songbirds migrating at night and only a few species of seabirds and resting birds. The Federal Agency for Nature Conservation regularly refers in its comments based on current case law to the fact that the killing or injury of individual specimens does not violate the prohibition defined in section 44 subsection 1 no. 1 of the Federal Nature Conservation Act in every case, but only if there is a significant increase in the risk of collision-related losses of individual specimens. In view of the fact that a converter platform is an individual structure with a close spatial link to an offshore wind farm, a significantly increased collision risk cannot be assumed with regard to the platform. In the specific approval procedure, suitable measures must also be taken to minimise the risk of birds colliding with the turbine. According to the current state of knowledge, a cumulative assessment of the impacts of up to 25 converter platforms in combination with wind farms is unlikely to significantly impair the avifauna.

5.2.1.3 Submarine cabling systems

According to the current state of knowledge, the operation of submarine cable systems will not have any significant negative impacts on seabirds and migratory birds that violate the prohibition of killing and injury pursuant to section 44 subsection 1 no.1 of the Federal Nature Conservation Act. When laying the submarine cable systems, the tall cable-laying ships can attract migratory birds with their intense lighting. Due to the short duration of the laying phase, the risk of a violation of species conservation prohibitions can be excluded according to the current state of knowledge. Suitable measures must also be taken on the construction ships to minimise attraction from lighting, taking into account occupational safety aspects.

5.2.2 Section 44 subsection 1 no. 2 of the Federal Nature Conservation Act (prohibition of disturbance)

As described above, various native European wild bird species as defined in Art. 1 of the Wild Birds Directive occur in the planning area, including the red-throated diver, the black-throated diver, the little gull, the sandwich gull, the common tern, the Arctic tern, the common gull, the northern fulmar, the northern gannet and the common guillemot. Against this background, the compatibility of the plan with section 44 subsection 1 no. 2 of the Federal Nature Conservation Act in conjunction with Art. 5 of the Wild Birds Directive must be ensured.

According to section 44 subsection 1 no. 2 of the Federal Nature Conservation Act it is prohibited to significantly disturb wild animals of strictly protected species during their breeding, rearing, moulting, hibernation and migration periods, whereby a disturbance shall be deemed significant if it causes the conservation status of the local population of a species to worsen.

The species conservation assessment pursuant to section 44 subsection 1 no. 2 of the Federal Nature Conservation Act refers to the population-relevant disturbances of local stocks, the occurrence of which varies in the areas covered by the plan. The results of the species conservation assessment are therefore subsequently represented for individual areas or groups of areas with comparable occurrences.

5.2.2.1 Areas and sites for offshore wind turbines

The species conservation assessment is based on the following considerations with regard to seabird species pursuant to Annex I of the Wild Birds Directive as well as species with another conservation status and those with a relatively high incidence in the EEZ:

Divers (*Gavia stellata* and *Gavia arctica*)

Red-throated diver (*Gavia stellata*) and black-throated diver (*Gavia arctica*) are common migratory seabird species in the northern hemisphere with breeding areas in boreal and arctic regions of Europe, Asia and North America. The global population of the red-throated diver is estimated at 200,000-600,000 individuals, of which about 42,100 - 93,000 pairs occur in the European breeding population (BIRDLIFE INTERNATIONAL 2015). The number of breeding pairs for the black-throated diver in Europe is assumed to be between 53,800 and 87,800. The global population consists of approximately 275,000 - 1,500,000 individuals (BIRDLIFE INTERNATIONAL 2015). Both types of divers do not breed in Germany, but can be found there mainly during the species-specific migration periods and in winter.

The local population of divers must be taken into account for the assessment of a significant disturbance of resting divers. This is a subset of the NW European winter resting population, known as the offshore population of divers. The NW European biogeographical population, which includes the red-throated divers resting in Germany, declined sharply in the years 1970-1990, especially in Russia and Fennoscandia. Despite stable and sometimes increasing population trends, such as in the UK, the population has not yet regained its original number. The causes of this negative development are anthropogenic in nature and include environmental pollution, such as oil spills. The oil disaster of the tanker "Erika" off the French coast, resulted in the death 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 in populations. The population of the black-throated diver suffered equally from these and other interventions in its natural habitat and also showed declines in population over the past 30 years. Despite the development of new potential breeding areas, e.g. in the northeast of Poland and in Ireland, the black-throated diver population continues to decline (BIRDLIFE INTERNATIONAL 2015).

Because the population has not yet fully recovered or is still in decline, both species are included in some European lists of endangered species, such as "SPEC 3" ("Species of European Conservation Concern, but showing negative development and unfavourable protection status"). Red-throated divers and black-throated divers also belong to the species listed in Annex I of the EU Wild Birds Directive and are also listed in the ordinance to establish the "Sylt Outer Reef – Eastern German Bight" nature conservation area.

Apart from the alarming trends in the European populations, red-throated and black-throated divers are particularly susceptible to disturbance. Already during ship-based bird counts, it became apparent that divers are disturbed at a great distance from the approaching ship and fly away (GARTHE et al. 2002). Current findings in studies confirm the deterrent effect on divers triggered by ships. The red- and black-throated divers are among the bird species most sensitive to ship traffic in the German North Sea. (MENDEL et al. 2019, FLIESSBACH et al. 2019).

In the German North Sea, the red-throated diver is the most common species of diver, accounting for about 90% of individuals identified at species level. The following information therefore focuses exclusively on the biology of the red-throated diver.

Biology of the red-throated diver (*Gavia stellata*)

From a taxonomic standpoint, red-throated divers belong to one of the oldest orders of birds, the Gaviiformes order, which in turn has only one family (Gaviidae). The Gaviidae family comprises five species of the genus *Gavia*, all of which breed in boreal and Arctic waters. First findings of the *Gavia* genus originate from the Miocene (20 million years) and were identified in Austria (MLIKOWSKY 1998).

Until a few years ago, findings about the biology of the red-throated diver mainly originated from investigations carried out by means of observation or banding in the breeding areas. The lack of knowledge was mainly due to the absence of large-scale survey programmes and research projects that were initiated only in the 1990s (e.g. ESAS), but also to the lack of specific survey methods.

Red-throated divers are the smallest of the five diver species and are ideally adapted to life on the water. They usually stay on the water and only move to their nests on land during the breeding season. Red-throated divers sleep on the water and are active all day, especially in the breeding season at high latitudes during periods of 24-hour daylight. Due to their body shape, red-throated divers can lift off from the water more easily than other types of divers. When in danger, they often fly away rather than diving. (ILICEV & FLINT 1985).

Due to their stature and anatomy, red-throated divers can swim and dive very efficiently in search of food. Like all diver species, they look for their prey visually, floating on the water surface, in the water column. Red-throated divers are opportunistic in their feeding habits and eat fish with a length of up to 25 cm, usually herring and cod and invertebrates living in the water (DURINCK et al. 1994). Dives to hunt for prey usually last 40 to 50 seconds, maximum 90 seconds. The diving depth is two to nine metres and can reach a maximum of 21 m (BAUER & GLUTZ VON BLOTZHEIM 1966).

Red-throated divers is a species that lives a long time. The highest age determined to date using banding was 23 years (ILICEV & FLINT 1985). Ages of up to 31 years were found when other diver species were banded in North America Red-throated divers reach reproductive maturity late, usually at the age of three years. Brood pairs are regarded as particularly loyal to location and look for the same breeding location every year. The breeding period begins in May. The nests usually have two eggs, in rare cases three (ILICEV & FLINT 1985, DICKSON 1993). Observations in the breeding areas indicate that breeding does not take place in some years due to unfavourable conditions, destruction or occupation of the breeding site. During the breeding season, the nests are constantly at risk of the eggs being stolen by, e.g. skuas or Arctic foxes. When confronted with danger, the red-throated diver leaves the nest, showing its susceptibility to disturbances. They do not return to the nest for a prolonged period of time depending on the intensity of the disturbance (ILICEV & FLINT 1985). In addition, observations show that often only one young bird is fed when feeding conditions are unfavourable and to improve the chances of survival of the adult birds. The competition between the young birds is very pronounced as is the case with all species of divers. Although young birds can already swim and dive from their first day of life, they only start looking for food on their own at the age of six to eight weeks. Families usually stay together for eight to ten weeks (ILICEV & FLINT 1985).

With regard to the mortality of eggs and young birds, it is known from the breeding areas on the Shetland Islands that only about 30% of the eggs hatched into young birds and about 20% became fledglings. This means that with a statistical nest size of 1.8 eggs per breeding pair, 0.37 to 0.46 young birds survive per season (BUNDY 1976 cited in ILICEV & FLINT 1985). A five-year study in Canadian breeding areas found a slightly higher reproduction rate of 0.63 young birds per pair and year. These studies also showed a higher loss rate in eggs than in hatched young birds. The mortality of the young birds was higher in the first three weeks after hatching, accounting for 82% of the total losses (DICKSON 1993). A relatively high survival rate of 0.84 individuals per year was found for adult red-throated divers using satellite telemetry. (SCHMUTZ 2014).

All previous studies have shown that the mortality rate of young birds in the first and second year of life is quite high at 38 – 40%. Mortality in adult birds, on the other hand, is only 16% (MENDEL et al. 2008).

According to the current state of knowledge, red-throated divers can be classified as very sensitive owing to their reproduction strategy. This sensitivity is related to the late onset of the reproductive phase, the low reproduction rate and the high mortality of the young stages (loss of eggs and young birds). The rather low mortality rate of adult individuals cannot compensate for the rather low reproductive success described here. It is therefore assumed that negative developments in the population can only be reversed slowly even if conditions improve (MENDEL et al. 2008).

<u>Importance of the main concentration area of divers in the German North Sea</u>

The main concentration area of the divers in spring (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety 2009) is the natural and functional unit of the local population of the divers in the German North Sea EEZ.

In the explanatory memorandum to the amendment to the Federal Nature Conservation Act 2007, the concept of local population is defined as follows: "A local population comprises those (partial) habitats and areas of activity of individuals of a species that are spatially and functionally connected in a way that is sufficient for the habitat requirements of the species". According to this definition, the term local population is linked to a function.

All previous findings from research, offshore wind farm monitoring and Natura 2000 site monitoring confirm the spatial functional relationship between the occurrence of divers in spring and the main concentration area identified. In its comments of 13.05.2019, the Federal Agency for Nature Conservation stated that the main concentration area would be of particular importance solely on account of the high population numbers in the German North Sea and that the high functional importance of the main concentration area as a food habitat would become evident at the same time. The predictability and availability of food resources (in the form of small, energy-rich, predominantly pelagic fish) on the hydrographic fronts occurring in this area of the German Bight is the cause for the concentration of divers in the main concentration area (SKOV & PRINS 2001). Sufficient availability of food resources is also a basic prerequisite for the survival of the sea divers resting here. The Federal Office for Nature Conservation further states that the main concentration area is of special importance over and above the fact that the aggregation of the birds takes place there immediately before their return to the Arctic and boreal breeding areas of Eurasia. Before migrating home, the divers build up fat reserves in their spring resting habitats, which are essential not only for the return journey, but especially for reproductive success in the subsequent breeding period. It is generally true that breeding is less successful when birds are in poor physical condition in spring (DIERSCHKE & GARTHE 2006).

According to the current state of knowledge, the main concentration area is home to 11,000 divers in spring and thus 10% of the superordinate, north-western European winter rest population with 110,000 individuals.

(Durinck et al. 1994, Schwemmer et al. 2019). Due to the occurrence of this high percentage of the superordinate population, Germany has a special responsibility to protect the sea divers.

The main concentration area of divers in spring, as defined in the position paper of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2009), extends west of the North Frisian islands and includes area II of the "Sylt Outer Reef – Eastern German Bight" nature conservation area. It is home to a significant proportion of the diver population in the German waters of the North Sea.

The demarcation of the main concentration area of divers is based on a data availability defined as very good and on technical analyses for which there is broad scientific acceptance. The area comprises all areas of very high diver density and most of the areas with high diver density. The use of the different areas in the main concentration area is linked to the very dynamic salinity front system in the eastern German Bight. The formation of the nutrient-rich fronts is not static and predictable, but takes place dynamically between the nutrient-rich water masses of the Elbe and the stratified water masses of the open North Sea (KRAUSE et al. 1986). The demarcation of the main concentration area comprises possible areas of formation of the frontal system and was chosen in the west and southwest in such a way that all important and known regular occurrences of divers are included. However, irregular occurrences can be found – during the vernal migration of the species from the wintering areas to the breeding grounds – west of the boundary of the main concentration area and also in the EEZ north of the East Frisian Islands, although they do not belong to a larger, contiguous area regularly used at medium to very high density.

According to the assessment made in the position paper of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2009), the resting population of divers in the German North Sea areas will not be significantly disturbed by further offshore wind energy projects, even if they are considered cumulatively pursuant to Art. 5 of the Wild Birds Directive and section 44 subsection 1 no. 2 of the Federal Nature Conservation Act if it is ensured that no further habitat losses – beyond the projects already effectively approved – for divers occur in the main concentration area as a result of offshore wind farms. The definition of the main concentration area in the German EEZ in 2009 was therefore one of the most important measures to reduce significant detrimental impacts at population level. The definition was based on the state of knowledge from the operational monitoring of the Danish wind farm Horns Rev I in 2008/2009 and from research and monitoring data from the German North Sea.

Ruling out the possibility of further offshore wind farms is intended to counteract any worsening of the conservation status of the local population as a result of the adverse effects of offshore wind farms. Already in the position paper of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2009) it is stated that in certain cases a relocation of sites to less sensitive areas is to be pursued.

Several offshore wind farms have been in operation within the main concentration area since 2014. The results of monitoring according to the Standard Investigation Concept have shown consistently and unambiguously the pronounced avoidance behaviour of divers in relation to wind farms. Statistically significant decreases of the abundance at distances of more than 10 km, starting from the edge of the respective wind farm, were found for all of them (BIOCONSULT SH & Co.KG 2017, BIOCONSULT SH & Co.KG 2018, INSTITUTE FOR APPLIED ECOSYSTEM RESEARCH 2017, INSTITUTE FOR APPLIED ECOSYSTEM RESEARCH 2018PLANUNGSGEMEINSCHAFT UMWELTPLANUNG OFFSHORE WINDPARK 2015, IBL

UMWELTPLANUNG et al. 2016a, IBL UMWELTPLANUNG et al. 2017b).

In a jointly commissioned project with the Research and Technology Centre, the Federal Agency for Nature Conservation and Nuclear Safety and the Federal Maritime and Hydrographic Agency initiated a new evaluation and assessment of all the data on the occurrence of the red-throated divers in the German North Sea EEZ up to and including 2017. The overall goal of the project was to assess the cumulative effects of the operation of the offshore wind farms on the occurrence of divers. Within the scope of the current Research and Technology Centre study, the findings of Garthe et al. (2015) were augmented by data from research and monitoring from the first years of the operating phase of offshore wind farms (GARTHE et al. 2018). This study clearly shows that the avoidance behaviour of divers in relation to wind farms is far more pronounced than originally assumed. Whereas earlier decisions for individual approval procedures were based on an average deterrence distance of 2 km (defined as a complete avoidance of the wind farm area including a buffer zone of 2 km around a wind farm (see Federal Ministry for the Environment, Nature Conservation and Nuclear Safety 2009)) for divers, the current findings show that this deterrence distance, known as the calculated total habitat loss, has more than doubled to an average of 5.5 km. The calculated total habitat loss of 5.5 km is used to quantify the habitat loss, similar to the previous deterrence distance of 2 km. This is subject to the purely statistical assumption that there are no divers up to a distance of 5.5 km from an offshore wind farm. A statistically significant decrease in abundance up to 10 km away was found in the current Research and Technology Centre study. This shows that the diver population has shifted to the central part of the main concentration area (GARTHE et al. 2018). For the statistically significant decrease in abundance, this is not a total avoidance but a partial avoidance with increasing diver densities up to 10 km away from a wind farm.

MENDEL et al. (2019) also demonstrated that the diver occurrence to the west of Sylt is concentrated in an area furthest away from the wind farm projects that have already been completed. In the opinion of the scientists, the possibility cannot be ruled out that divers, whose food and distribution are closely associated with the hydrographic frontal system of the Jutland Current, (SKOV & PRINS 2001, HEINÄNEN et al. 2018) will in the future only be able to respond to the dynamics in the availability of their food to a limited extent due to their extensive avoidance of wind farms. At the same time, a consolidation of the occurrence could lead to intraspecific competition for food resources (SCHWEMMER et al. 2019).

A current population calculation in the main concentration area for the period 2002 to 2012 yielded an increase in the number of red-throated divers, which has remained at a constant level since 2012. However, a decrease in the red-throated diver population has been recorded since 2012 for the entire German North Sea, the sub-areas of which have different local significance as habitats for divers. These findings illustrate the special significance of the main concentration area as a habitat for divers in the German North Sea in view of the pronounced avoidance behaviour and associated habitat loss (SCHWEMMER et al. 2019).

In summary, the data from the monitoring of the operating phase has shown that the construction and operation of offshore wind farms have adverse effects on divers. The extent of the identified adverse impacts (calculated total habitat loss, statistically significant decrease in abundance) exceeds the impact forecasts of the authorities and the assumptions of the position paper of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2009), which has been the basis for the qualitative assessment of cumulative impacts since 2009. It is therefore necessary to assess the significance of the adverse effects with regard to a violation of the prohibition of disturbance pursuant to section 44 subsection 1 no. 2 of the Federal Nature Conservation Act. According to this law, a significant disturbance is deemed to occur when the conservation status of the local population of a species worsens as a result of the disturbance.

The explanatory memorandum to the Act describes the conditions under which a worsening of the conservation status of the local population is to be assumed: "A worsening of the conservation status is to be assumed in particular if the chances of survival, breeding success or reproductive capacity are reduced, whereby this must be examined and assessed specific to the species and for each individual case" (Bundestag Printed Paper 16/1500, p. 11).

Assessment of cumulative effects of avoidance behaviour on the conservation status of the local population

The species conservation assessment is always carried out on the basis of all scientific findings available to the Federal Maritime and Hydrographic Agency and the Federal Agency for Nature Conservation. To assess a significant disturbance of the local population of divers in the German North Sea EEZ, the results from the current analysis and evaluation of the avoidance effects of divers and the population development of the dominant red-throated divers are used (GARTHE et al. 2018, SCHWEMMER et al. 2019) along with all available information from scientific literature.

According to the current state of knowledge, the operation of offshore wind farms has adverse effects on the local population of divers (GARTHE et al. 2018, SCHWEMMER et al. 2019). Identification of the adverse effects of avoidance behaviour was based on the evaluation of data collected both by means of standardised investigation methods in accordance with the Standard Investigation Concept (StUK4 2013) and by means of independent recording methods (telemetry under the scope of the DIVER research project).

Identification of the adverse effects on divers based on the extensive data has been carried out using modern statistical methods which represent the current state of good scientific practice both nationally and internationally.

Two parameters essentially describe the extent of the impact of offshore wind farms: a) the calculated total habitat loss and b) the statistically significant decrease in abundance.

While the identification of adverse effects has been very clear and consistent in terms of the extent of the impact, the causality remains unclear. It has been established that the construction and operation of offshore wind farms have led to the identified adverse effects on divers. However, the construction and operation of offshore wind farms is associated with a complex logistics and infrastructure in which the turbines *per se* (without electricity-generating rotation of the rotors), the operation of the turbines (electricity-generating rotation of the rotors), the lighting, maintenance and repair of the turbines, as well as the shipping traffic linked to the construction and operation can be considered among the main disruptive factors. Other uses are also added cumulatively, such as non-wind-farm shipping and fishing activities. According to the current state of knowledge, it is not possible to further clarify and limit the cause of the disturbance.

In its comments of 13.05.2019, the Federal Agency for Nature Conservation reviewed and evaluated the current findings from the Research and Technology Centre study (GARTHE et al. 2018, SCHWEMMER et al. 2019) with regard to the significance of the incident for the local population of divers. In its comments, the Federal Agency for Nature Conservation says that expulsions or displacements of individual animals from their previously used areas are only of no relevance to the population as long as they can easily move into suitable alternative areas with little disturbance. The Federal Agency for Nature Conservation finds that the assumptions made in the position paper (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety 2009) of a calculated total habitat loss within a radius of 2 km, starting from the periphery of a wind farm, are exceeded by the adverse effects identified during the monitoring of the operating phase of the offshore wind farms. The deterrence-related habitat loss within the main concentration area thus amounted to 19% of the total area of 7,332 km^2.

In its comments, the Federal Agency for Nature Conservation notes that, in view of the existing pressures and the particular relevance of the main concentration area as a resting and feeding area for divers immediately before they return to their breeding grounds, it can be assumed that the implementation of further projects in the main concentration area would worsen the conservation status of the local population. According to the Federal Agency for Nature Conservation, the worsening of the conservation status of the local population can only be prevented by not permitting any projects within the main concentration area that would lead to additional displacement or habitat loss for the divers as a result of disturbances. In this context, the Federal Agency for Nature Conservation points out that in order to reduce the impairment to the level found to be acceptable in 2009, in addition to not repowering the Butendiek offshore wind farm, further wind farms in the main concentration area must also be avoided.

After reviewing and evaluating all available information on the detrimental effects on divers, the Federal Maritime and Hydrographic Agency agrees with the Federal Agency for Nature Conservation's assessment. Specifically, the assessment of the significance of the adverse effects of the operation of offshore wind farms on the conservation status of the local population of divers is carried out taking into account 1) the extent of the adverse effects identified on divers, 2) the specific biological characteristics of divers (in particular the most abundant species, red-throated divers, accounting for 90% of the total) and 3) the conservation status of the local population.

1) Assessment of adverse effects of the operation of offshore wind farms

The calculated total habitat loss is used to assess the significance of adverse impacts of offshore wind farms on divers (GARTHE et al. 2018, Garthe et al. 2019). In addition, the statistically significant decrease in abundance of the divers is taken into account in the assessment of the conservation status of the local population.

The analysis of avoidance effects has been carried out on the basis of scientifically accepted statistical methods (GARTHE et al. 2018, MERCKER 2018a). The results of the statistical analyses have shown that the calculated total habitat loss due to the strong avoidance behaviour of the divers is on average 5.5 km from the edge of a wind farm. Cumulatively, for all offshore wind farms located within the main concentration area (specifically the projects "Butendiek", "Dan Tysk", "Sandbank", "Amrumbank West", "North Sea East" and "Seawind South/East"), the avoidance behaviour leads to a loss of 19% of the food and rest habitat within the main concentration area. The intensity of the impact is therefore to be classified as high. The results from the monitoring of offshore wind farms have so far provided no indications of acclimatisation effects. It can therefore be assumed that the impact is permanent.

For the statistically significant decrease in abundance calculated, the effects must also be classified as permanent and intensive.

2) Assessment of the sensitivity of the red-throated diver species to external impacts

The biological characteristics described in the section on the biology of the red-throated diver are to be used to assess the sensitivity of the red-throated diver to external factors. These include lifespan, age at onset of reproductive phase, reproductive potential, mortality rate in young birds and mortality rate in adult individuals.

The red-throated diver is a species with a long lifespan (shown to be 23 years), which reaches reproductive maturity comparatively late at two or even three years. Red-throated divers have very low reproduction potential (one nest with two eggs per breeding pair and year) and a very high mortality rate of young birds (statistically 0.38 to 0.68 young birds survive per breeding pair and year). In contrast, the mortality rate among adult individuals is relatively low at 16%.

The low mortality of adult individuals cannot compensate for the relatively low natural reproductive success. Red-throated divers are therefore highly sensitive in terms of their reproductive characteristics and long lifespan. It is therefore assumed that negative developments in the population can only be reversed slowly even if conditions improve (MENDEL et al. 2008).

3) Assessment of the conservation status of the local diver population in the German North Sea EEZ

The evaluation of the conservation status of the local divers population is based on population changes and changes in distribution and abundance within the main concentration area.

Since the offshore wind farms were constructed and commissioned, the distribution patterns of divers within the main concentration area in the German Bight have changed significantly in spring. The divers have been clearly displaced from parts of the nature conservation area (area II, Sylt Outer Reef – Eastern German Bight) to the southwest within the main concentration area. (GARTHE et al. 2018). The current distribution patterns of the divers are partly caused by the avoidance behaviour in relation to the offshore wind farm "Butendiek", which is located in the north-eastern part of sub-area II of the "Sylt Outer Reef – Eastern German Bight" nature conservation area. The displacement of divers from a previously preferred food and rest habitat, the concentration in another habitat, which may be less preferable in the opinion of the experts, and above all the restricted use of the entire main concentration area when searching for food due to the avoidance behaviour, must also be monitored in the future with regard to the effects on the population and, in particular, reviewed when the Site Development Plan is updated.

A current population calculation in the main concentration area for the period 2002 to 2012 yielded an increase in the number of red-throated divers, which has remained at a relatively constant high level since 2012. However, a decrease in the red-throated diver population has been recorded since 2012 for the entire German North Sea, the sub-areas of which have different local significance as habitats for divers. These observations illustrate the special functional significance of the main concentration area as a habitat for divers in the German North Sea in view of the pronounced avoidance behaviour and associated habitat loss (SCHWEMMER et al. 2019).

Results of the assessment of adverse impacts on the local diver population

The assessment showed that divers are highly sensitive from a population biological point of view, that the main concentration area is of great importance for the conservation of the local population and that the adverse effects of avoidance behaviour are intensive and permanent.

In order to prevent the conservation status of the local population from worsening as a result of the cumulative effects of the wind farms, it is necessary to keep the site of the main concentration area currently available to the divers free of new wind farm projects, outside the effective zones of existing wind farms.

The Federal Maritime and Hydrographic Agency concludes that a significant disturbance as defined in section 44, subsection 1 no. 2 of the Federal Nature Conservation Act 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.

Areas N-1, N-2 and N-3

The section where areas N-1, N-2 and N-3 are located is used by divers primarily as a transit area and during migration periods. According to the current state of knowledge, these areas lie outside the main concentration area of divers identified in the German Bight.

Based on the available data from research projects and monitoring of wind farm clusters or individual projects, the Federal Maritime and Hydrographic Agency concludes that these areas are not of high importance for the German North Sea diver resting population. Areas N-1, N-2 and N-3 are located at distances between 55 km and 100 km from the main diver concentration area. In its comments on individual projects in areas N-1 and N-2, the Federal Agency for Nature Conservation also does not assume that a disturbance has occurred. This would include a cumulative assessment if no further offshore wind farm projects were approved in the main concentration area.

Finally, according to the current state of knowledge, it is not assumed that offshore wind farms in areas N-1, N-2 and N-3 will not violate the prohibition of disturbance pursuant to section 44 subsection 1 no. 2 of the Federal Nature Conservation Act.

Area N-4

Area N-4 lies in the southernmost part of the main concentration area of the divers and boundaries on area II of the "Sylt Outer Reef – Eastern German Bight" nature conservation area. Due to its composition, it is part of the habitat of the diver in the German Bight. According to the current state of knowledge, area N-4 is very important for divers. Even taking into account the interannual variability of the distribution patterns, a high occurrence of divers was observed in this area in the years prior to the construction of the offshore wind farms.

The analysis and evaluation of cumulative effects of offshore wind farms showed that the avoidance effects on divers are much more pronounced (Garthe et al. 2018) than was originally assumed in the decisions on individual approval procedures of the Federal Maritime and Hydrographic Agency and in the position paper of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2009). The offshore wind farms "Amrumbank West", "North Sea East" and "Sea Wind Southeast" have contributed to the observed displacement of divers from a previously preferred feeding and resting habitat and the concentration in another habitat, which experts believe may be less preferred. Furthermore, the main concentration area can only be used to a limited extent for searching for food due to the observed avoidance of wind farms. There have been no signs that the divers acclimatise to the wind farms. As the adverse cumulative effects on divers appear to be intense and permanent, monitoring activities must be continued and the significance of the cumulative effects assessed with a view to subsequent use of the area for offshore wind energy also in the years to come. In line with the previous remarks, area N-4 is not designated and will be assessed for subsequent use. In addition to monitoring measures, mitigation measures must be adopted in order to rule out the possibility of a violation of the prohibition of disturbance as defined in section 44 subsection 1 no. 2 of the Federal Nature Conservation Act with the necessary certainty. An extension of area N-4 for the use of offshore wind energy beyond the priority area established in the maritime spatial planning for the German EEZ in the North Sea (EEZ North Sea Spatial Plan Ordinance 2009) is therefore excluded for reasons of ensuring species conservation for the divers species group.

Area N-5

The sub-sites of area N-5 are located in the main concentration area of the divers in the German EEZ of the North Sea.

In March and April, a high density of divers occur in all sub-sites. The entire area N-5 is very significant for the resting population of divers.

The long-term data series for the environmental impact studies, the monitoring of the offshore wind farm and the monitoring of the Natura 2000 sites show that high densities are regularly recorded in this area. Area N-5 boundaries to the north on the Danish bird sanctuary "Southern North Sea", which also has a high occurrence of marine divers.

The results from monitoring and research projects show that the disturbance of the divers or habitat loss is significantly higher than expected (Welcker & Nehls 2016; Dierschke et al. 2016, Garthe et al. 2018, Mendel et al. 2019). Current results from the wind farm projects in area N-5 and its surroundings show significant average avoidance distances of 10 to approx. 15 km from the current operational monitoring (BioConsult SH & Co.KG 2017, BioConsult SH & Co.KG 2018, Institute for Applied Ecosystem Research 2018).

The analysis and evaluation of cumulative effects of offshore wind farms showed that the avoidance effects on divers are much more pronounced (Garthe et al. 2018) than was originally assumed in the decisions on individual approval procedures of the Federal Maritime and Hydrographic Agency and in the position paper of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2009). The offshore wind farms "Dan Tysk" and "Sandbank" in area N-5 have contributed to the observed displacement of divers from a previously preferred feeding and resting habitat and the concentration in another habitat, which experts believe may be less preferred. Furthermore, the main concentration area can only be used to a limited extent for searching for food due to the observed avoidance of wind farms. There have been no signs that the divers acclimatise to the wind farms. As the adverse cumulative effects on divers appear to be intense and permanent, monitoring activities must be continued and the significance of the cumulative effects assessed with a view to subsequent use of the area for offshore wind energy also in the years to come. In addition to strict monitoring measures, mitigation measures must be adopted in order to rule out the possibility of a violation of the prohibition of disturbance as defined in section 44 subsection 1 no. 2 of the Federal Nature Conservation Act with the necessary certainty.

An extension of area N-5 for the use of offshore wind energy beyond the "Dan Tysk" and "Sandbank" offshore wind farms in operation at the time of this assessment, and specifically in relation to site N-5.4, which was assessed in the (preliminary) drafts of the Site Development Plan, is therefore incompatible with the prohibition in section 44 subsection 1 no. 2 of the Federal Nature Conservation Act based on the current state of knowledge. A reassessment would be advisable if other nature conservation findings were to emerge in the future.

The exclusion of site N-5.4 is based on the scope of the cumulative adverse effects of the offshore wind farms already identified in the area of the main concentration area of divers in the German EEZ of the North Sea. The identified 19% loss of feeding and resting habitat within the main concentration area, which is important for the preservation of the local divers population, in connection with the identified statistically significant decrease in the abundance of the divers, prohibits a possible increase of the area of intervention for reasons of species conservation for the species group of divers.

Contrary to the technical opinion of the potential operators of site N-5.4, which is described in the (preliminary) drafts of the Site Development Plan and currently under assessment, the negative effects of site N-5.4, seen as an individual project, do not play a role in the assessment of a significant disturbance of the local population or a worsening of the conservation status of the local population. Pursuant to section 44 subsection 1 no. 2 of the Federal Nature Conservation Act, the cumulative effects of the project must always be assessed in connection with existing impacts, in this case particularly in connection with the offshore wind farms already in operation in the area of the main concentration area of the divers. A significant disruption of the conservation status of the local population of divers as a result of additional habitat and functional losses in the main concentration area would also significantly affect the protective aims of the nature reserve "Sylt Outer Reef – Eastern German Bight" Area II (Sylt Nature Conservation Act, 2017). The conservation of habitats and the related functions of the main concentration area of divers is intended to ensure that divers are always able to find sufficient equivalent food habitats inside and outside the nature conservation area (Ordinance on the Establishment of the Nature Conservation Area "Sylt Outer Reef – Eastern German Bight" - NSGSylV, Area II) during the spring resting period.

In its comments of 13 May 2019, the Federal Agency for Nature Conservation stated the following: it is prohibited to take an isolated view of a disruptive event in view of section 44 subsection 1 no. 2 of the Federal Nature Conservation Act. Gellermann (2011, p. 123) explains: Since the conservation status is measured based on the totality of the impacts that affect the size and distribution of the local population from a longer-term perspective, it must be expected, particularly in cases where endangered species (in this case divers) are affected, that a disruptive individual event can be the "straw that breaks the camel's back" when combined with other stress factors affecting the local population. In this context, Gellermann

(2011, p. 123) explicitly points out that "the deterrence-induced loss of habitat for hibernating divers caused by the construction of an offshore wind farm may be insignificant in itself, whereas it may well have population-relevant impacts and exceed the threshold of significance in interaction with other disruptive factors".

After a thorough assessment, the Federal Agency for Nature Conservation concluded in its statement of 13 May 2019 that, in order to reduce the impairment to the scope of impairments deemed acceptable in 2009, it is necessary to not only abandon the subsequent use of the "Butendiek" wind farm, but also forego further offshore wind farms in the main concentration area.

In accordance with the precautionary principle pursuant to section 3 UVPG and in order to exclude the possibility of a significant disturbance as defined in section 44 subsection 1 no. 2 of the Federal Nature Conservation Act with the necessary certainty, further cumulative effects resulting from the construction of further offshore wind turbines in area N-5 must be avoided.

The precautionary principle is a principle of environmental law with crucial importance. It stipulates not only that measures must be taken in the event of imminent damage caused by specific environmental threats, but also that risks must be mitigated before a threat arises. This gives rise to the obligation to take environmental precautions with as much foresight and planning as possible to prevent environmental hazards or damage from occurring in the first place. Especially in the case of complex or not yet fully understood interrelationships, an environmental threat may arise when potentially non-threatening individual impacts are combined. For example, the construction of just a single wind turbine – or even a single offshore wind farm – may be seen as unproblematic by all sides, but a different perspective and approach must be applied when there is a large number of turbines or projects. The precautionary principle makes it possible to take action in the event of a concern, based on actual evidence, about possible environmental harm (KUHBIER & PRALL 2010).

In line with the previous remarks, area N-5 is not designated and will be assessed for subsequent use. Site N-5.4, which is still under assessment in the (preliminary) drafts of the Site Development Plan, is excluded from further planning for offshore wind turbines based on the results of the assessment of the cumulative adverse effects on the conservation status of the local population of divers (see chapters 7.4 and 7.5 of the Site Development Plan).

Areas N-6 to N-13

Areas N-6 to N-13 are of only low importance for divers, according to available information. All areas are far away from the food-rich front system west of the North Frisian Islands at water depths of more than 40 m. The characteristics of these areas do not constitute a suitable habitat for divers.

The long-term data series from the environmental impact studies and from the monitoring of the offshore wind farms shows that divers in this area have always been recorded in very small numbers and mainly in flight during the migration periods. In comparison to the distribution area for divers, only low diver densities were observed in the adjacent areas in spring (IFAÖ 2016).

According to the current state of knowledge, the possibility of the prohibition as defined in section 44 subsection 1 no. 2 of the Federal Nature Conservation Act being violated for divers can be ruled out with the necessary certainty.

Little gull (*Larus minutus*)

The population of the little gull in Europe is divided into two biogeographical populations. The population breeding from Scandinavia to Russia and partly occurring 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 Sea and southeast to the Caspian Sea. In Germany, the little gull can be found mainly during the main migration periods in water bodies and coastal areas of Lower Saxony and Schleswig-Holstein (MENDEL et al. 2008).

With regard to possible impairments of the little gull by the wind turbines, the collision risk is to be classified as low. Studies have shown that the flight altitude is usually below the rotor height (<30m) (MENDEL et al. 2015).

GARTHE & HÜPPOP (2004) rated the little gull as very insensitive to offshore wind turbines with a WSI value (Wind Farm Sensitivity Index) of 12.8. Investigations of potential avoidance behaviour of the little gull do not provide a uniform picture to date.

Due to the relatively low observed densities of the little gull in area N-1 up to and including area N-13 and their limited correlation to the main migratory periods specific to the species, the areas should be assumed to be of low to at most medium importance for the little gull. Investigations of the resting population related to observed maximum densities, which are subject to interannual fluctuations. Cumulative effects on the population are not to be expected according to the current state of knowledge.

Finally, according to the current state of knowledge, it is not assumed that offshore wind farms in areas N-1 up to including N-13 will not violate the prohibition of disturbance pursuant to section 44 subsection 1 no. 2 of the Federal Nature Conservation Act.

Terns

According to the current state of knowledge, cumulative effects on the population are not to be expected. The sandwich terns (*Sterna sandvicensis*) breeding in Germany belong to the biogeographical population of Western Europe, whose breeding occurrences also extend along the coastal regions of France, Ireland and Great Britain and to a lesser extent in the Baltic Sea. The population size is estimated at 160,000 - 186,000 individuals (WETLANDS INTERNATIONAL 2012). The German breeding population is comprised of around 9,700 - 10,500 breeding pairs. During the breeding season, the sandwich terns move within a radius of 30 to 40 km from their breeding colony. In bodies of water with depths of more than 20 m, there are hardly any sandwich terns seeking food. The resting population in the German EEZ is estimated to be 110 - 430 individuals year-round. There are even fewer in sub-area II of the "Sylt Outer Reef – Eastern German Bight" nature conservation area (MENDEL et. al. 2008).

The population is usually found to have a stable status. The species is considered "not endangered" in the European Red List (BIRD LIFE INTERNATIONAL 2015).

Arctic and common terns (*Sterna paradisea, Sterna hirundo*) only occur sporadically in area N-1 up to and including area N-13. Higher, albeit low, densities were only found close to the coast in the course of the long-range flight transect survey (INSTITUTE FOR APPLIED ECOSYSTEM RESEARCH et al. 2015, BIOCONSULT SH GMBH & CO.KG 2015).

Terns generally appear to avoid the area within a wind farm. They are not completely displaced, but rather shift their movements to outer areas (PETERSEN et. al. 2006).

Based on this information and the current state of knowledge, the Federal Maritime and Hydrographic Agency does not assume that the population of terns will be disturbed by offshore wind farms. Finally, according to the current state of knowledge, it is not assumed that offshore wind farms in areas N-1 up to including N-13 will not violate the prohibition of disturbance pursuant to section 44 subsection 1 no. 2 of the Federal Nature Conservation Act.

Auks

Guillemot (*Uria aalge*)

The common guillemot is one of the most common seabird species in the northern hemisphere and has a breeding population of about 2.35 - 3.00 million individuals in Europe. The most important breeding areas are on the rocky coasts of Iceland and the British Isles, the latter with about 1.4 million individuals (BirdLife International 2015). Studies on ringed guillemots have shown that individuals of these large colonies migrate to the southern and eastern North Sea for food during the post-breeding period (Tasker et al. 1987).

The only breeding colony of the common guillemot in the German North Sea is on the Helgoland archipelago. The breeding population was estimated to be around 2,600 pairs in 2012 (Grave 2013). In summer, the animals mostly stay in the vicinity of the breeding colony, and only occur in low densities within a radius of 30 km. In autumn and winter, common guillemots increasingly spread to the offshore area with water depths between 40 and 50 m (Mendel et al. 2008).

With a WSI of 12.0, the common guillemot belongs to the lower third of the species investigated by Garthe & Hüppop (2004) for sensitivity to disturbance. The long-term investigations since the "alpha ventus" project was commissioned, on the other hand, have shown that auks clearly demonstrate avoidance behaviour (analysed together with the razorbill). Based on ship recordings, up to 75% reduction in the probability of sighting was found within the wind farm (BioConsult SH GmbH &Co.KG & Institute for Applied Ecosystem Research 2014). The results of the StUKplus project "TESTBIRD" support these observations. During the flights in the first winter months of the operational monitoring (2009/2010 and 2010/2011), no auks were sighted within the wind farm and within a radius of 1-2 km. Starting in 2012, auks were observed for the first time outside the wind farms. (Mendel et al. 2015).

Based on the current state of knowledge, no significant effects on the population of the common guillemot caused by offshore wind farms are to be expected due to the large total population and the extensive geographical distribution. Finally, according to the current state of knowledge, it is not assumed that offshore wind farms in areas N-1 up to including N-13 will not violate the prohibition of disturbance pursuant to section 44 subsection 1 no. 2 of the Federal Nature Conservation Act.

Razorbill (*Alca torda*)

In addition to the guillemot, the razorbill is another auk frequently seen in the North Sea. The European population is estimated to be around 1 million individuals. The largest share, about 60%, breeds on rocky coasts of Iceland, followed by other important breeding areas in the British Isles and Norway (BirdLife International 2015). The only breeding colony in Germany is on Helgoland, with only about 15 - 20 breeding pairs (Grave 2013). Razorbills limit their food search to the vicinity of the breeding ground during breeding season. The winter resting population in the German North Sea is estimated at 7,500 individuals. The birds are more likely to stay within the 20 m depth range (Mendel et al. 2008).

Due to the geographically limited distribution of the breeding areas, the razorbill is included in the Red List of Breeding Birds (Südbeck et al. 2008) in category "R" (species with geographic restriction). The breeding colony on Helgoland is, however, very small and will probably not be crucial for the occurrence of the razorbill in the German North Sea.

The Federal Maritime and Hydrographic Agency is currently not in possession of any information that would indicate that a disturbance as defined in section 44 subsection 1 no. 2 of the Federal Nature Conservation Act has occurred. Finally, according to the current state of knowledge, it is not assumed that offshore wind farms in areas N-1 up to including N-13 will not violate the prohibition of disturbance pursuant to section 44 subsection 1 no. 2 of the Federal Nature Conservation Act.

Northern fulmar (*Fulmarus glacialis*)

The northern fulmar is a typical deep-sea bird and is present in the German EEZ all year round. Its main distribution area lies away from the coast beyond the 30 m depth line (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 EU27 Red List (BIRDLIFE INTERNATIONAL 2015).

To date, little is known about the reactions of the northern fulmar to offshore wind farms under construction or in operation as low sighting rates and insufficient data generally do not enable reliable conclusions to be drawn. However, a WSI of only 5.8 indicates a very low sensitivity to disturbance (GARTHE & HÜPPOP 2004).

Based on the current state of knowledge, no significant effects on the population of the northern fulmar caused by offshore wind farms are to be expected. Finally, according to the current state of knowledge, it is not assumed that offshore wind farms in areas N-1 up to including N-13 will not violate the prohibition of disturbance pursuant to section 44 subsection 1 no. 2 of the Federal Nature Conservation Act.

Gannet *(Sula bassana)*

The breeding population of the northern gannet in Europe is estimated at about 683,000 breeding pairs. (BIRDLIFE INTERNATIONAL 2015). Helgoland is the only breeding ground for the northern gannet in the German Bight. Other European breeding areas can be found along the Norwegian coast and on the well-known Scottish island of Bass Rock. As a highly mobile species, the northern gannet makes use of extensive food habitats within a radius of up to 120 km from the breeding colony (MENDEL et al. 2008). Although the occurrence (isolated) of the northern gannet is area wide, it is listed in the Red List under category "R" (species with geographical concentration) due to the heavy concentration of breeding areas (SÜDBECK et al. 2008). Its population, however, is considered "not endangered" according to European threat categories (least concern, LC) (BIRDLIFE INTERNATIONAL 2015).

There are relatively few, statistically insignificant studies of northern Gannet, suggesting a potential avoidance behaviour towards wind turbines. Unambiguous conclusions are usually not possible due to the increased mobility of the species and, similar to the kingfisher, the associated low sighting rates and small numbers of samples.

With regard to the low, interannually fluctuating occurrence of the northern gannet, a low to medium importance as resting and feeding areas is to be assumed for the areas.

Based on the current state of knowledge, no significant effects on the population of the northern gannet caused by offshore wind farms are to be expected. Finally, according to the current state of knowledge, it is not assumed that offshore wind farms in areas N-1 up to including N-13 will not violate the prohibition of disturbance pursuant to section 44 subsection 1 no. 2 of the Federal Nature Conservation Act.

Seagulls

Seagulls are generally widespread in the North Sea and can be observed near the coast or offshore, depending on the species. The recorded densities of the individual species can therefore differ considerably from each other. Among the most common types, beside the little gull which was already discussed separately, are the lesser black-backed gull, common gull, European herring gull, great black-backed gull and black-legged kittiwake.

In general, offshore wind turbines seem to attract seagulls or not influence their local distribution. They are also known as prominent ship followers. Among the seagulls, the common gull is the only species to be classified in SPEC category 2 (species concentrated in Europe with negative population development and poor conservation status) (BIRDLIFE INTERNATIONAL 2004a). The population of the biogeographical population, which mainly occurs in Germany, is estimated at 1,200,000 - 2,000,000 individuals and exhibits stable population development (WETLANDS INTERNATIONAL 2012). In the pan-European red List and the EU27 list, it is considered "not endangered" (BIRDLIFE INTERNATIONAL 2015).

Based on the current state of knowledge, no significant effects on the population of the common gull caused by offshore wind farms are to be expected. Finally, according to the current state of knowledge, it is not assumed that offshore wind farms in areas N-1 up to including N-13 will not violate the prohibition of disturbance pursuant to section 44 subsection 1 no. 2 of the Federal Nature Conservation Act.

5.2.2.2 Platforms

All converter platforms are planned in direct physical proximity to offshore wind farms and thus in their immediate vicinity. It can therefore be assumed that the adjacent wind farms' deterrence of seabirds and resting birds sensitive to disturbance and the associated loss of habitat by the converter platforms will only increase marginally. The same applies to the deterrence and barrier effect on migratory birds.

Based on the current state of knowledge, it therefore cannot be assumed that there will be a disturbance of resting and migratory birds as defined in section 44 subsection 1 no. 2 of the Federal Nature Conservation Act relevant to species conservation law.

5.2.2.3 Submarine cabling systems

Deterrence of seabirds, resting birds and migratory birds is limited to the small-scale laying of submarine cables, which is very temporary. These disturbances will not go beyond the disruptions generally associated with slow shipping traffic. For this reason, the planned submarine cable systems are not expected to cause any disturbance relevant to species conservation under section 44 subsection 1 no. 2 of the Federal Nature Conservation Act.

5.3 Bats

Migration movements of bats across the North Sea are still scarcely documented and largely unexplored. There is a lack of specific information on migratory species, migration corridors, migration heights and migration concentrations. Information available to date confirms merely that bats, especially species that travel long distances, fly over the North Sea.

5.3.1 Section 44 subsection 1 no. 1 and no. 2 of the Federal Nature Conservation Act

5.3.1.1 Areas and sites for offshore wind turbines

The possibility of isolated collisions with wind turbines cannot be ruled out according to technical findings. From the perspective of species conservation law, the same considerations generally apply as those already outlined in the assessment of avifauna. Pursuant to Art. 12 (1) no. 1 a) of the Habitats Directive, all intentional forms of capture or killing of bat species removed from nature are prohibited. Collision with offshore structures is not intentional killing. In this context, explicit reference can be made to the guideline on the strict protection system for animal species of Community interest within the framework of the Habitats Directive, which in II.3.6 marg. no. 83 assumes that the killing of bats is an unintentional killing which must be continuously monitored in accordance with Art. 12 (4) of the Directive. There are no indications to support investigation of further violations pursuant to Art. 12 (1) of the Habitats Directive.

Experience and results from research projects and wind farms already in operation will also be sufficiently accounted for in other procedures.

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

However, it can be expected that any adverse impacts of wind turbines on bats will be prevented by using the same prevention and mitigation measures devised to protect bird migration.

According to the current plans, violation of neither the prohibition of killing and injury pursuant to section 44 subsection 1 no. 1 of the Federal Nature Conservation Actnor the prohibition of a significant disturbance pursuant to 44 subsection 1 no. 2 of the Federal Nature Conservation Act is the be expected.

5.3.1.2 Platforms

The possibility of isolated collisions with converter platforms cannot be ruled out according to technical findings. From the perspective of species conservation law, the same considerations generally apply as those already outlined in the assessment of avifauna. Pursuant to Art. 12 (1) no. 1 a) of the Habitats Directive, all intentional forms of capture or killing of bat species removed from nature are prohibited. Collision with offshore structures is not intentional killing. In this context, explicit reference can be made to the guideline on the strict protection system for animal species of Community interest within the framework of the Habitats Directive, which in II.3.6 marg. no. 83 assumes that the killing of bats is an unintentional killing which must be continuously monitored in accordance with Art. 12 (4) of the Directive. There are no indications to support investigation of further violations pursuant to Art. 12 (1) of the Habitats Directive.

Experience and results from research projects at the "alpha ventus" test field and from turbines and platforms already in operation will also be sufficiently accounted for in other procedures.

Since the converter platforms are individual structures which, according to the current plans, are located in the immediate vicinity of the offshore wind farms, violation of neither the prohibition of killing and injury pursuant to section 44 subsection 1 no. 1 of the Federal Nature Conservation Act nor the pursuant to section 44 subsection 1 no. 2 of the Federal Nature Conservation Act is to be expected

It can be expected that any adverse impacts of converter platforms on bats will be prevented by using the same prevention and mitigation measures devised to protect bird migration.

5.3.1.3 Submarine cable systems

Based on the current state of knowledge, the laying and operation of submarine cable systems will not have any relevant effects on bats under species conservation law.

6 Assessment of the implications

Within the framework of this SEA, the areas, sites, platforms and submarine cable routes in the Site Development Plan will be subject to a separate assessment as to their implications for the conservation objectives of the nature conservation areas. The assessment of the implications carried out here for sites and areas takes place at the planning level and does not replace the corresponding assessment at the level of concrete projects carried out within the framework of planning approval procedures. To this respect, further avoidance and mitigation measures are to be expected if these are deemed necessary after assessment of the implications in the context of planning approval procedures in order to rule out the possibility of the protective aims of the protected areas being impaired by use within or outside a nature conservation area.

6.1 Legal basis

The German EEZ of the North Sea includes the nature conservation areas "Sylt Outer Reef – Eastern German Bight", "Borkum Reef Ground" and "Dogger Bank", which were established by decree on 22 September 2017.

Essentially, construction of artificial installations and buildings in nature conservation areas is prohibited. However, this does not apply to projects and plans to generate energy from wind and the laying or operation of submarine cables, subject to an admissibility assessment (see sections 6 subsection 1, 7 subsection 6 Ordinance on the establishment of the conservation area "Sylt Outer Reef – Eastern German Bight" – NSGSylV[36]; sections 4 subsection 1, 5 subsection 6 Ordinance on the Establishment of the Nature Conservation Area "Borkum Reef Ground" - NSGBRgV[37]; section 4 subsection 1, 5 subsection 6 Ordinance on the Establishment of the Nature Conservation Area "Dogger Bank"- NSGDgbV[38]). These projects and plans must be assessed for their implications for the conservation objectives of the respective ordinance.

They are permissible if, according to section 34 subsection 2 of the Federal Nature Conservation Act, they cannot lead to significant impairments of the components of the nature conservation area significant for the conservation objective or if they meet the requirements according to section 34 subsections 3 to 5 of the Federal Nature Conservation Act (see section 7 subsection 2 of the NSGSylV, section 5 subsection 2 of the NSGBRgV and section 5 subsection 2 of the NSGDgbV). Compatibility according to the Federal Nature Conservation Act has to be examined according to the assessment previously carried out for the FFH sites. By a decision made by the EU Commission dated 12.11.2007, the nature conservation areas in the EEZ were previously included under European law as FFH sites in the first updated list of sites of Community importance in the Atlantic biogeographical region according to Art. 4 subsection 2 of the Habitats Directive (Official Journal of the EU, 15.01.2008, L 12/1), so an FFH assessment of the implications has already been carried out within the framework of the Spatial Offshore Grid Plan.

[36] Ordinance on the establishment of the conservation area "Sylt Outer Reef – Eastern German Bight" of 22 September 2017 (Federal Law Gazette I p. 3423)

[37] Ordinance on the establishment of the conservation area "Borkum Reef Ground" of 22 September 2017 (Federal Law Gazette I p. 3395)

[38] Ordinance on the establishment of the conservation area "Dogger Bank" of 22 September 2017 (Federal Law Gazette I p. 3400)

sections 34 and 36 of the Federal Nature Conservation Act stipulate that plans or projects which, individually or in conjunction with other plans or projects, may significantly affect an FFH and EU bird sanctuary and which do not directly serve the administration of the area must be assessed for their implications for the conservation objectives and protective aims of a Natura 2000 site. This is also applicable to projects outside the site which, individually or in combination with other projects or plans, are likely to significantly undermine the conservation objectives of the sites. With the designation of the nature conservation areas, this assessment now refers to the conservation objective of these nature conservation areas. The assessment of the implications under the Habitats Directive has a narrower scope than the SEA as it is limited to reviewing the impact using the protective aims established for the protected area.

The total area of the three nature conservation areas amounts to 7,947 km² (26.8% of the EEZ zone of the North Sea), the nature conservation area "Sylt Outer Reef – Eastern German Bight" covers a site of 5,603 km² (11.0%), the nature conservation area "Borkum Reef Ground" covers a site of 652 km^2, and the nature conservation area "Dogger Bank" covers 1,692 km^2.

The factors as a whole are the habitat types "reefs" and "sandbanks" according to Annex I of the Habitats Directive, certain fish species and marine mammals according to Annex II of the Habitats Directive (mud lamprey, waite, harbour porpoise, grey seal and seal), and various bird species according to Annex I of the Birds Directive (red-throated diver, black-throated diver, little gull, sandwich tern, common tern, Arctic tern, fulmar, gannet, common scoter, great skua, pomarine skua, common gull, lesser black-backed gull, kittiwake, guillemot, razorbill). Species listed in Annex IV of the Habitats Directive, e.g. the harbour porpoise, must be strictly protected everywhere, including outside the defined protected areas.

Under the scope of the Site Development Plan, individual sites and areas for offshore wind turbines and platforms are planned exclusively outside nature conservation areas in accordance with the 2009 Spatial Plan for the EEZ of the North Sea. Individual submarine cable routes and gates are planned in or near the "Borkum Reef Ground", "Sylt Outer Reef – Eastern German Bight" and "Dogger Bank" nature conservation areas.

In addition, the assessment of the implications also takes into account the remote effects of the rules defined within the EEZ on the protected areas in the adjacent 12 nautical mile zone and the adjacent waters of the neighbouring states. This also affects the assessment and consideration of functional relationships between the individual protected areas and the coherence of the network of protected areas pursuant to section 56 subsection 2 of the Federal Nature Conservation Act since the habitat of some target species (e.g. avifauna, marine mammals) can extend over several protected areas due to their large radius of activity.

6.2 Impact assessment of the Site Development Plan with respect to the habitat types

An impact assessment of the planned sites and platforms for the conservation objectives of the "Borkum Reef Ground" and "Sylt Outer Reef – Eastern German Bight" nature conservation areas with regard to marine mammals and avifauna is conducted jointly for areas, sites and platforms in chapter 6.3.

In addition to existing cables (by the end of 2025), cable routes for two

interconnectors crossing the "Dogger Bank" nature conservation area and a cross connection between the platforms in areas N-1 and N-2 on the periphery of the "Borkum Reef Ground" nature conservation area are the subject of the impact assessment of the cable routes.

The NOR-5-2 grid connection system, which is under assessment for site N-5.4 in the (preliminary) drafts of the Site Development Plan, would also almost completely cross the "Sylt Outer Reef – Eastern German Bight" nature conservation area and could lead to potential negative effects on the protected area (see alternative assessment in chap. 9.3.3). Since the site still under consideration in the (preliminary) drafts is not defined due to nature conservation and environmental reasons, a route through the "Sylt Outer Reef – Eastern German Bight" nature conservation area is also not defined.

6.2.1 Impact assessment of the conservation objective of the "Borkum Reef Ground" nature conservation area

6.2.1.1 Impact assessment of the Site Development Plan for the sites and platforms in sites N-1 and N-2 with regard to habitat types

The construction and operation of sites and platforms in sites N-1 and N-2 are not expected to have any significant effects on the habitat types "reef" and "sandbank" with their characteristic and endangered biocoenoses and species due to the small-scale nature of the effects relevant in particular for reefs, such as sediment drift and sediment shifts of the material released during the construction phase, and the location outside the "Borkum Reef Ground" nature conservation area. In both areas, no additional rules were defined under the Site Development Plan.

6.2.1.2 Impact assessment of the Site Development Plan for the cable routes connecting areas N-1, N-2 and N-8 and the cross connection between platforms in areas N-1 and N-2 with regard to habitat types

Each of the cable routes connecting the converter platforms in areas N-1, N-2 and N-8 cross the "Borkum Reef Ground" nature conservation area over a distance of approx. 21 km. The system for the connection of area N-1 also runs over a distance of around 8 km at the northern edge of the "Borkum Reef Ground" nature conservation area. A possible cross connection between platforms in areas N-1 and N-2 (2 cables) runs along the "Borkum Reef Ground" nature conservation area at a distance of at least 700 m for a distance of about 8 km each. The nature conservation area is of regional importance for the habitat types "sandbank" and "reefs" with their characteristic and endangered biocoenoses and species. All the systems mentioned above are not defined under the Site Development Plan.

Effects of submarine cables are usually limited to the laying phase and are therefore limited both temporally and spatially. The connecting routes cross the "sandbank" habitat. The "reef" habitat defined in the Habitats Directive, which is sensitive to cable laying, is not crossed on the route according to a report (BioConsult, 2011). Individual local reef components have been identified on the route as suspected reef areas, but they are small in size and can probably be bypassed as part of the detailed routing (BioConsult, 2011). With regard to possible operational effects, the cable configurations and installation depths specified in the Site Development Plan are also not expected to have any significant effects.

Based on current findings, the possibility of the laying and operation of submarine cable systems causing significant impairment of the

"Borkum Reef Ground" nature conservation area in its components that are essential for the protective aim or conservation objective can be ruled out, even if the cumulative effects of the submarine cable systems are considered. An alternative assessment for the route was already carried out as part of the study "Variants of a cable corridor ("Harfe") in the "Borkum Reef Ground" area.

6.2.1.3 Impact assessment of the Site Development Plan for the route of the transboundary submarine cable system "COBRAcable" with regard to habitat types

The route under construction for the transboundary submarine cable system "COBRAcable" crosses the "Borkum Reef Ground" nature conservation area over a distance of approx. 21 km. A detailed FFH assessment of the implications was carried out as part of the approval procedure.

For "COBRAcable", an examination of alternatives was conducted as part of the establishment of the BFO-N since considerable impairment of FFH habitat in the area of the requested route could not be ruled out based on the findings available at the time. In the environmental report for BFO-N 2013/2014, it was therefore highlighted that the question of which route would be the most compatible from an ecological standpoint had to be clarified in the individual approval procedure.

The FFH assessment of the implications carried out as part of the approval procedure concludes that any significant impairment of the occurrence of FFH habitats can be ruled out as a result of the route optimisation undertaken as part of the procedure, which largely bypasses identified reef occurrences on the route and minimises the crossing of protected coarse sand biotopes, and the conditions laid down in the approval decision. The cable configurations and installation depths are also not expected to have any significant effects in terms of operation.

6.2.1.4 Impact assessment of the Site Development Plan for gate N-I (Ems) with regard to habitat types

The gate N-I (Ems) is directly adjacent to the "Borkum Reef Ground" nature conservation area. The distance to the "Lower Saxon Wadden Sea National Park" is about 5 km.

Effects of submarine cables are usually limited to the laying phase and are therefore limited both temporally and spatially. The planned gate I (Ems) crosses the "sandbank" habitat type. The sensitive "reef" habitat type defined in the Habitats Directive is not crossed according to a report (BioConsult, 2011). Individual local reef components have been identified on the route as suspected reef areas, but they are small in size and can probably be bypassed as part of the detailed routing according to a report as part of the individual approval procedure (BioConsult, 2011). No other routes to this gate are defined in the Site Development Plan since there is no possibility of extending this route in the coastal waters. With regard to possible operational effects, the cable configurations and installation depths specified in the Site Development Plan are also not expected to have any significant effects. An alternative assessment for the route was carried out as part of the study Variants of a cable corridor ("Harfe") in the Borkum Reef Ground area.

The possibility of significant impairments of the "Borkum Reef Ground" nature conservation area through definition of the N-I gate can be ruled out. An assessment of the submarine cable route in the coastal waters was performed as part of the continuation of the Spatial Planning Programme for the state of Lower Saxony.

6.2.2 Impact assessment with the conservation objective of the nature conservation area "Sylt Outer Reef –

Eastern German Bight"

6.2.2.1 Impact assessment of the Site Development Plan for the sites and platforms in area N-4 with regard to habitat types

The construction and operation of sites and platforms in area N-4 are not expected to have any significant effects on the habitat types "reef" and "sandbank" with their characteristic and endangered biocoenoses and species due to the small-scale nature of the effects relevant in particular for reefs, such as sediment drift and sediment shifts of the material released during the construction phase, and the location outside of nature conservation areas. The nearest occurrence of the habitat type "sandbank" in the "Sylt Outer Reef – Eastern German Bight" nature conservation area is at a distance of at least 10.1 km and thus outside the drift distances discussed in the scientific literature.

This also applies to the" habitat type "reef, which has a known occurrence at least 18.7 km away. To this extent, nutrient and pollutant concentrations which could impair the nature conservation area in its components essential for the protective aims or conservation objective are not expected to be released. No rules are defined for area N-4 under the Site Development Plan. The area is currently under assessment for subsequent use.

6.2.2.2 Impact assessment of the Site Development Plan for the sites and platforms in sites N-5 and N-11 with regard to habitat types

With respect to the evaluation of the long-distance effects on reefs and sandbanks, the previous comments on the sites and platform locations in area N-4 apply accordingly. No rules are defined for area N-5 under the Site Development Plan. The area is currently under assessment for subsequent use.

6.2.2.3 Impact assessment of the Site Development Plan for the cable routes to connect area N-4 with regard to habitat types

The cable routes in operation to connect the area N-4 cross the "Sylt Outer Reef – Eastern German Bight" nature conservation area over a distance of approx. 17 km and border the "Helgoland seabird sanctuary". The shortest distance between the planned submarine cable routes and the nature conservation area is approx. 10 km. For these cable routes, a corresponding FFH assessment of the implicationsaccording to section 34 of the Federal Nature Conservation Act has already been carried out as part of the two approval procedures[39]. As outlined in the approval notices, the possibility of considerable impairments to the components of the "Sylt Outer Reef – Eastern German Bight" nature conservation area essential for the protective aims or the conservation objectives caused by laying or operating the submarine cable systems can be excluded according to the current state of knowledge. Cable laying is also not expected to have significant effects for the "Helgoland seabird sanctuary" based on the current state of knowledge.

6.2.2.4 Impact assessment of the Site Development Plan for the cable routes to connect area N-5 with regard to habitat types

The cable route in operation to connect area N-5 crosses the "Sylt Outer Reef – Eastern German Bight" nature conservation area over a distance of approx. 86 km. The route boundaries

[39] HelWin1 and HelWin alpha approval notice from 2.7.2012 and HelWin2 and HelWin beta approval notice from 20.03.2014.

on the "Helgoland seabird sanctuary" in the south. For this cable route, an assessment of the implications pursuant to section 34 of the Federal Nature Conservation Act has already been carried out as part of the "SylWin1 and SylWin alpha" approval procedure[40].

A reef was identified in the area of the SylWin1 route based on the available route surveys from the "SylWin1 and SylWin alpha" project. It was possible, however, to bypass the reef by diverting the route. Due to the extensive bypass of the reef as part of the detailed routing with a minimum distance of 420 m, no impairments of the FFH habitat type "reefs", which are sensitive to being covered, are to be expected. With regard to possible operational effects, the cable configurations and installation depths specified in the Site Development Plan are also not expected to have any significant effects.

6.2.2.5 Impact assessment of the Site Development Plan for the cable route for the three-phase submarine cable system for the connection of the "Butendiek" wind farm with regard to habitat types

The route currently in operation for the three-phase submarine cable system for the connection of the "Butendiek" offshore wind farm to the "SylWin alpha" converter platform crosses the "Sylt Outer Reef – Eastern German Bight" nature conservation area over a distance of approx. 37 km. A detailed FFH assessment of the implications has already been carried out as part of the approval procedure.

The project-related FFH assessment of the - implications concludes that the possibility of considerable impairments to the components of the "Sylt Outer Reef" nature conservation area essential for the protective aims or conservation objective caused by laying or operating the submarine cable systems can be excluded according to the current state of knowledge. Reef areas identified based on the route surveys can be bypassed as part of detailed routing at a sufficient distance (minimum distance 50 m) so that no significant impairments of the FFH habitat types "reefs" and "sandbanks" are to be expected. In terms of operation, no significant impairments from e.g. electromagnetic fields or heat emissions are to be expected from the intended cable configurations and installation depths.

6.2.2.6 Impact assessment of the Site Development Plan for the route of the transboundary submarine cable system "COBRAcable" with regard to habitat types

The route under construction for the transboundary submarine cable system "COBRAcable" crosses the "Sylt Outer Reef – Eastern German Bight" nature conservation area over a distance of approx. 83 km. A detailed FFH assessment of the implications was carried out as part of the approval procedure.

For "COBRAcable", an examination of alternatives was conducted as part of the establishment of the BFO-N since considerable impairment of FFH habitat in the area of the requested route could not be ruled out based on the findings available at the time. In the environmental report for BFO-N 2013/2014, it was therefore highlighted that the question of which route would be the most compatible from an ecological standpoint had to be clarified in the individual approval procedure.

The FFH assessment of the implications carried out as part of the approval procedure concludes that any significant impairment of the occurrence of FFH habitats can be ruled out as a result of

[40] SylWin1 and SylWin alpha approval notice from 23.05.2013.

the route optimisation undertaken as part of the procedure, which largely bypasses identified reef occurrences on the route and minimises the crossing of protected coarse sand biotopes, and the conditions laid down in the approval decision. The cable configurations and installation depths are also not expected to have any significant effects in terms of operation.

6.2.2.7 Impact assessment of the Site Development Plan for the cable route of the transboundary submarine cable system "NordLink" with regard to habitat types

The "NordLink" route currently under construction crosses the "Sylt Outer Reef – Eastern German Bight" nature conservation area over a distance of approx. 91 km. The "NordLink" project was approved in October 2014. A detailed FFH assessment of the implications was carried out as part of the approval procedure.

For "NordLink", an examination of alternatives was conducted as part of the initial establishment of the BFO-N since considerable impairment of FFH habitat type in the area of the requested route could not be ruled out based on the findings available at the time. In the environmental report for BFO-N 2012, it was therefore highlighted that the question of which route would be the most compatible from an ecological standpoint had to be clarified in the individual approval procedure.

The FFH assessment of the implications carried out as part of the approval procedure concludes that the route optimisation undertaken as part of the procedure and the conditions laid down in the approval decision can rule out any significant impairment of the occurrence of FFH habitat types "reefs" and "sublittoral sandbanks". Known reef occurrences are not crossed by the cable route. As part of the detailed routing, the cable route was adjusted in such a way that any reef occurrences are bypassed at a distance of at least 50 m. No reefs are used even when clearing decommissioned cables. Consequently, no significant impairment as defined in section 34 of the Federal Nature Conservation Act is to be expected with regard to the FFH habitat type "reefs". The route crosses the FFH habitat type "sublittoral sandbank" over a distance of about 14 km. Based on the available results from the individual approval procedure, there is no indication that the project will have a significant impact on the FFH habitat type "sublittoral sandbank" as defined in section 34 of the Federal Nature Conservation Act.

The cable configurations and installation depths are also not expected to have any significant effects in terms of operation.

6.2.2.8 Impact assessment of the Site Development Plan for the section of the transboundary submarine cable route between gates N-III and N-VII on the edge of the protected area with regard to habitat types

Contrary to planning in the BFO-N, the transboundary submarine cable system between gates N-III und N-VII with a parallel route of approx. 63 km runs parallel to the nature conservation area "Sylt Outer Reef – Eastern German Bight" for only approx. 27 km.

The occurrence of the FFH habitat type "reef" or "sandbank" in the route corridor can be excluded according to the current state of knowledge as the route section lies outside the nature conservation area "Sylt Outer Reef – Eastern German Bight" in the Elbe-Urstromtal with its very fine sediments. Moreover, the fine material that is released in this area is transported away to the north-west due to the prevailing current close to the bottom and does not drift into the nature conservation area. With regard to possible operational effects, the cable configurations and installation depths specified in the Site Development Plan are also not expected to have any significant effects.

6.2.3 Impact assessment of the conservation objective of the "Dogger Bank" nature conservation area

6.2.3.1 Impact assessment of the Site Development Plan for Interconnectors with regard to habitat types

As part of the Site Development Plan, six additional cross-border power lines will be stipulated in the North Sea EEZ. Two connections crossing the "Dogger Bank" nature conservation area are planned. This includes one of two route variants for a transboundary submarine cable system to Great Britain, and a possible connection from the Netherlands in the direction of Norway. The route for the submarine cable system to Great Britain starts at gate N-III and then runs parallel to "Europipe 2" in a northerly direction to the northern edge of shipping route 2. From there, the route leads west to the crossing of "Europipe 1", then parallel to the "Norpipe" pipeline and along the western border of the EEZ to gate N-XII. The cable crosses the "Dogger Bank" nature conservation area over a length of 50.3 km and crosses the Wintershall (C) pipeline within the protected area. The route crosses the FFH habitat type "sandbank" in the area of the EEZ inside and outside the protected area over a total length of approx. 63.6 km. The occurrence of additional FFH habitat types in the route areas is not known at present.

The second route, which crosses the "Dogger Bank" nature conservation area, runs northwards from gate N-XIV, crosses the "Norpipe" pipeline and then runs parallel to the "Norpipe" pipeline to gate N-XI. This route crosses the sandbank within the protected area over a distance of approx. 54.2 km. The occurrence of additional FFH habitat types in the route areas is not known at present.

With an absolute gradual functional loss of a maximum of approx. 2.4 ha and a relative functional loss of a maximum of approx. 0.001%, these two submarine cable systems are not expected to have any significant effects on the FFH habitat type "sandbank".

6.3 Impact assessment of the Site Development Plan for protected species

6.3.1 Assessment of the implications pursuant to section 34 subsection 1 of the Federal Nature Conservation Act in connection with Art. 6 (3) of the Habitats Directive and in accordance with section 5 subsection 6 of the Ordinance on the Establishment of the Nature Conservation Area "Borkum Reef Ground"

Pursuant to section 34 subsection 1 of the Federal Nature Conservation Act and section 5 subsection 6 NSGBRgV, the plan in question must take into account the provisions in section 5 subsection 4 NSGBRgV in the official decision. Projects and plans must be assessed for their implications for the protective aims of a protected area before being approved or implemented if, individually or in combination with other projects or plans, they are likely to have a significant impact on the nature conservation area.

The Federal Maritime and Hydrographic Agency is responsible for the assessment of the implications according to section 34 of the Federal Nature Conservation Act and section 5 subsection 7 NSGBRgV.

The assessment of the plan's implications is based on the conservation objectives of the nearest "Borkum Reef Ground" nature conservation area. According to section 3, subsection 1 NSGBRgV, the protective aims of the Natura 2000 site must be achieved. Pursuant to section 3 subsection 2 no. 3 NSGBRgV, the conservation and restoration of the specific ecological values and functions of the area, in particular the populations of harbour porpoises and harbour seals and their habitats and natural population dynamics are to be protected.

Finally, under section 3 subsection 5 no. 1 to no. 5 NSGBRgV, the ordinance defines objectives for ensuring the conservation and restoration of the marine mammal species of harbour porpoise, harbour seal and grey seal mentioned in section 3 subsection 2 NSGBRgV, as well as for preserving and restoring 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 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 of marine mammal species referred to in subsection 3 no. 2 which is largely undisturbed and unaffected by local pollution, and in particular as a habitat of supra-regional importance for harbour porpoises in the East Frisian Wadden Sea,
- no. 3: of unfragmented habitats and the possibility of migration of the species of marine mammals listed in subsection 3 no. 2 NSGBRgV, in particular to neighbouring protected areas of the Wadden Sea and off Helgoland,
- no. 4: of the essential food resources of the marine mammal species listed in subsection 3 no. 2 NSGBRgV, in particular the natural population densities, age-group distributions and distribution patterns of the organisms which serve as the food resources for these marine mammal species; and
- no. 5: of the high vitality of individuals and species-typical age structure of fish and cyclostome populations and spatial and temporal distribution patterns and densities of their natural food resources.

6.3.1.1 Impact assessment of the Site Development Plan for areas N-1 to N-3 and associated sites and platforms with regard to marine mammals

Areas N-1, N-2 and N-3 of the present Site Development Plan in the German EEZ are located close to the "Borkum Reef Ground" nature conservation area, (EU code: DE 2104-301). This was stipulated by the ordinance of 22 September 2017.

The present plan defines sites and areas for wind turbines and platforms. The assessment of the potential impacts of the plan has shown that the construction and operation of offshore wind farms and platforms will not have significant adverse effects on marine mammals in areas N-1, N-2 and N-3.

The assessment has shown that the impact of noise from pile-driving during the installation of foundations for offshore wind turbines and platforms can have a significant impact on marine mammals, in particular harbour porpoises, if no noise mitigation measures are taken. In order to exclude significant impacts, in particular through disturbance of the local stock and the population of the respective species, implementation of strict noise protection measures is required. The plan contains a set of principles to this effect. In addition, noise protection measures that meet state-of-the-art science and technology were described under the scope of the species conservation assessment. Implementation of these measures will rule out the possibility of any significant disturbance of the existing situation in the areas and sites according to the current state of knowledge. Since 2008, the Federal Maritime and Hydrographic Agency has introduced regulations in its approval notices which contain binding threshold values for the pulsed noise level through pile-driving. The introduction of mandatory thresholds is justified by findings on triggering temporary shifts in the hearing levels of harbour porpoises. (Lucke et al., 2008, 2009). Compliance with the threshold values (160 dB single sound event level (SEL05) re 1µPa2s and 190 dB re 1µPa at a distance of 750 m) is monitored by the Federal Maritime and Hydrographic Agency using standardised measurement and evaluation methods. Additional noise protection measures for the coordination of parallel pile-driving work and the reduction of pollution in nature conservation areas are also derived from the noise protection concept of the Federal Minister for the Environment, Nature Conservation, and Nuclear Safety (2013) and are adapted, prescribed and also monitored by the Federal Maritime and Hydrographic Agency under the scope of individual approval procedures to the site- and project-specific characteristics. Since 2011, noise reduction systems have been deployed for all pile-driving work carried out in German waters of the North and Baltic Seas. Monitoring of noise protection measures has shown that they have been very effective since 2014, so that the possibility of a significant disturbance of the populations and associated impairment of the local population in the German EEZ of the North Sea can be ruled out.

The assessment of the potential impact of the plan has shown that the installation and operation of submarine cable systems will not have significant adverse effects on marine mammals in the vicinity of the cable routes. The possibility of any impairment of the conservation objectives of the "Borkum Reef Ground" nature conservation area as a result of the laying and operation of submarine cables of submarine cable systems inside and outside the "Borkum Reef Ground" nature conservation area can be ruled out with the necessary certainty, assuming that appropriate measures are carried out during implementation.

The possibility of any impairment of the conservation objectives of the "Borkum Reef Ground" nature conservation area as a result of the implementation of projects in areas N-1, N-2 and N-3 of the plan in question and compliance with the rules in the subordinate individual approval procedures can be ruled out with certainty.

An assessment of the implications of plan implementation in areas N-1, N-2 and N-3 pursuant to section 34 of the Federal Nature Conservation Act in conjunction with the conservation objectives of the "Sylt Outer Reef – Eastern German Bight" and "Dogger Bank" nature conservation areas with regard to marine mammals is not necessary due to the distance of these areas of the plan from the nature conservation areas.

6.3.1.2 Impact assessment of the Site Development Plan for sites N-4 to N-13 and associated sites and platforms with regard to marine mammals

An impact assessment of the plan in sites N-4 to N-13 pursuant to section 34 of the Federal Nature Conservation Act in conjunction with the conservation objectives of the "Borkum Reef Ground" nature conservation area with regard to marine mammals is not necessary according to current knowledge and due to the distance involved.

6.3.1.3 Impact assessment of the Site Development Plan for submarine cable systems with regard to marine mammals

The assessment of the potential impact of the plan has shown that the installation and operation of submarine cable systems will not have significant adverse effects on marine mammals in the vicinity of the cable routes. The possibility of any impairment of the conservation objectives of the "Borkum Reef Ground" nature conservation area as a result of the laying and operation of submarine cables of submarine cable systems inside and outside the "Borkum Reef Ground" nature conservation area can be ruled out with the necessary certainty, assuming that appropriate measures are carried out during implementation.

In the results, considerable impairment of the conservation objectives of the nature conservation area "Borkum Reef Ground" can be ruled out by implementing the plan and taking into consideration prevention and mitigation measures with the necessary certainty.

6.3.2 Assessment of the implications pursuant to section 34 subsection 1 of the Federal Nature Conservation Act in connection with Art. 6 (3) of the Habitats Directive and in accordance with section 5 subsection 6 of the Ordinance on the Establishment of the Nature Reserve "Sylt Outer Reef – Eastern German Bight" with regard to marine mammals and protected bird species

Pursuant to section 34 subsection 1 of the Federal Nature Conservation Act and section 7 subsection 6 NSGSylV, the plan in question must take into account the provisions pursuant to section 7 subsection 1 and subsection 4 NSGSylV in the official decision. Projects and plans must be assessed for their implications for the protective aims of a protected area before being approved or implemented if, individually or in combination with other projects or plans, they are likely to have a significant impact on the nature conservation area.

The Federal Maritime and Hydrographic Agency is responsible for the assessment of the implications according to section 34 of the Federal Nature Conservation Act and section 7 subsection 7 NSGSylV.

The assessment of the implications of the plan is based on the conservation objects of the "Sylt Outer Reef – Eastern German Bight" nature conservation area. Pursuant to section 1 NSGSylV, the nature conservation area joins the FFH site "Sylt Outer Reef" and the European bird sanctuary "Eastern German Bight" and divides them as stipulated in section 2 subsection 4. NSGSylV into two areas: area I is the area of the "Sylt Outer Reef" while area II is the area of the "Eastern German Bight".

According to section 3, subsection 1 NSGSylV, the protective aims of the Natura 2000 sites must be achieved. Pursuant to section 3 subsection 2, no. 3 NSGSylV, the conservation and restoration of the specific ecological values and functions of the area, in particular the populations of harbour porpoises, harbour seals, grey seals and seabird species and their habitats and natural population dynamics are to be protected.

6.3.2.1 Impact assessment based on the conservation objectives and protective aims of area I of the "Sylt Outer Reef – Eastern German Bight" nature conservation area with regard to marine mammals.

Finally, under section 4 subsection 3, no. 1 to no. 5 NSGSylV , the ordinance defines objectives for ensuring the conservation and restoration of the marine mammal species of harbour porpoise, harbour seal and grey seal mentioned in section 3 subsection 2 NSGSylV, as well as for preserving and restoring their habitats in area I.

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 and reproductive fitness, taking into account natural population dynamics, the 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 of marine mammal species referred to in subsection 1 no. 2 which is largely undisturbed and unaffected by local pollution, and especially as a particularly significant breeding, rearing, feeding and migration habitat for harbour porpoises in the southern area of the North Sea.
- no. 3: of unfragmented habitats and the possibility of migration of the species of marine mammals listed in subsection 1 no. 2 in Danish waters, to the immediately adjacent protected area for harbour porpoises of the state of Schleswig-Holstein and to the protected areas of the Wadden Sea and off Helgoland
- no. 4: of the essential food resources of the marine mammal species listed in subsection 1 no. 2, in particular the natural population densities, age-group distributions and distribution patterns of the organisms which serve as the food resources for these marine mammal species; and
- no. 5: of the high vitality of individuals and species-typical age structure of fish and cyclostome populations and spatial and temporal distribution patterns and densities of their natural food resources.

6.3.2.1.1 Impact assessment of the Site Development Plan for sites N-4, N-5, N-11 and N-13 and the associated sites and platforms with regard to marine mammals

The present plan defines sites and areas for wind turbines, platforms and cable systems. The assessment of the potential impacts of the plan has shown that the construction and operation of offshore wind farms and platforms and the laying and operation of the submarine cable systems will not have significant adverse effects on marine mammals in areas N-4, N-5, N-11 and N-13.

The assessment has shown that the impact of noise from pile-driving during the installation of foundations for offshore wind turbines and platforms can have a significant impact on marine mammals, in particular harbour porpoises, if no noise mitigation measures are taken. In order to exclude significant impacts, in particular through disturbance of the local stock and the population of the respective species, implementation of strict noise protection measures is required. The plan contains a set of principles to this effect. In addition, noise protection measures that meet state-of-the-art science and technology were described under the scope of the species conservation assessment. Implementation of these measures will rule out the possibility of any significant disturbance of the existing situation in the areas and sites according to the current state of knowledge. Since 2008, the Federal Maritime and Hydrographic Agency has introduced regulations in its approval notices which contain binding threshold values for the pulsed noise level through pile-driving. The introduction of mandatory thresholds is justified by findings on triggering temporary shifts in the hearing levels of harbour porpoises. (Lucke et al., 2008, 2009). Compliance with the threshold values (160 dB single sound event level (SEL05) re 1µPa2s and 190 dB re 1µPa at a distance of 750 m) is monitored by the Federal Maritime and Hydrographic Agency using standardised measurement and evaluation methods. Additional noise protection measures for the coordination of parallel pile-driving work and the reduction of pollution in nature conservation areas are also derived from the noise protection concept of the Federal Minister for the Environment, Nature Conservation, and Nuclear Safety (2013) and are adapted, prescribed and also monitored by the Federal Maritime and

Hydrographic Agency under the scope of individual approval procedures to the site- and project-specific characteristics.

Since 2011, noise mitigation systems have been deployed for all pile-driving work. Monitoring of noise protection measures has shown that they have been very effective since 2014, so that the possibility of a significant disturbance of the populations and associated impairment of the local population in the German EEZ of the North Sea can be ruled out.

In 2014, installation work was carried out for the "Butendiek" wind farm in the eastern site of the N-5 area. Two noise mitigation systems, one close to the pile and one far away from the pile, coupled with optimum control and real-time monitoring of the pile-driving process have made it possible to reliably comply with the noise protection values. Very intensive monitoring of construction activities by means of acoustic and visual methods could also help to structure the construction work in such a way as to avoid considerable impairment of the harbour porpoise. Pursuant to section 4 subsection 3 no. 2 and no. 3 of the NSGSylV, particular care must be taken to ensure the possibility of migration between the habitats in German and Danish waters and to the protected area of the state of Schleswig Holstein.

The assessment of the potential impact of the plan has shown that the installation and operation of submarine cable systems will not have significant adverse effects on marine mammals in the vicinity of the cable routes. The possibility of an impairment of the conservation objectives of the "Sylt Outer Reef – Eastern German Bight" nature conservation area as a result of the laying and operation of submarine cables inside and outside the nature conservation area can be ruled out with the necessary certainty, assuming such is done in compliance with the planning principles of the Site Development Plan and that appropriate measures are carried out during implementation.

Based on the current state of knowledge, the possibility of any impairment of the protective aims of area I of the "Sylt Outer Reef – Eastern German Bight" nature conservation area through the implementation of projects outside the nature conservation area in areas N-4, N-11 and N-13 of the present plan can be excluded with certainty.

An assessment of the implications of the plan implementation in areas N-4, N-5, N-11 and N-13 pursuant to section 34 of the Federal Nature Conservation Act in relation to the "Borkum Reef Ground" and "Dogger Bank" nature conservation areas is not necessary due to the distance from the nature conservation areas.

6.3.2.1.2 Impact assessment of the Site Development Plan for sites N-1 to N-3, N-6 to N-10 and N-12 and the associated sites and platforms with regard to marine mammals

The possibility of any impairment of the conservation objectives and protective aims of the "Borkum Reef Ground" nature conservation area as a result of the implementation of projects in sites N-1 to N-3, N-6 to N-10 and N-12 of the present plan can be ruled out with certainty due to the distance.

6.3.2.1.3 Impact assessment of the Site Development Plan for submarine cable systems with regard to marine mammals

The assessment of the potential impact of the plan has shown that the installation and operation of submarine cable systems will not have significant adverse effects on marine mammals in the vicinity of the cable routes. The possibility of an impairment of the conservation objectives of the "Sylt Outer Reef – Eastern German Bight" nature conservation area as a result of the laying and operation of submarine cables inside and outside the nature conservation area can be ruled out with the necessary certainty, assuming such is done in compliance with the planning principles of the Site Development Plan and that appropriate measures are carried out during implementation.

In the results, considerable impairment of the conservation objectives of area I of the "Sylt Reef Ground – Eastern German Bight" nature conservation area can be ruled out with the necessary certainty through implementation of the plan and if proper prevention and mitigation measures are carried out.

6.3.2.2 Impact assessment of the plan based on the conservation objectives and protective aims of area II of the "Sylt Outer Reef – Eastern German Bight" nature conservation area with regard to avifauna.

Pursuant to section 5 subsection 1, no. 1 NSGSylV, the conservation or, if necessary, the restoration of a favourable conservation status of bird species pursuant to Annex I of the Wild Birds Directive and of migratory bird species regularly occurring in this area belong to the conservation objectives of the nature conservation area.

Under section 5 subsection 1, no. 1 SGNSylV, the species red-throated diver (Gavia stellata, EU code A001) and black-throated diver (Gavia arctica, EU code A002) are listed.

The ordinance then sets objectives for area II under section 5 subsection 2, no. 1 to no. 4 SGNSylV related to ensuring the conservation and restoration of the bird species listed in section 5 subsection 1 SGNSylV and the functions of area II in accordance with 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 development; bird species with a negative population trend in their biogeographical population must be given particular consideration,
- no. 2: of the essential organisms serving as food resources for bird species, in particular their natural population densities, age-group distributions and distribution patterns,
- no. 3: of the increased biological productivity characteristic of the area on the vertical fronts 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 species-specific ecological functions, their integrity and spatial interdependence, and unhindered access to adjacent and neighbouring marine areas.

6.3.2.2.1 Impact assessment of the Site Development Plan for site N-4 and the associated sites and platformswith regard to protected bird species

Area N-4 is mainly located in the main concentration area of divers in the German EEZ of the North Sea and, like area N-5, is part of the habitat of divers in the German Bight.

According to the current state of knowledge, area N-4 is very important seasonally for divers. Even taking into account the interannual variability of the distribution patterns, a high occurrence of divers was observed in this area in the years prior to the construction of the offshore wind farms.

For the assessment of the significance of the adverse effects of the wind farms from the priority area for offshore wind energy "Northern Helgoland" (EEZ North Sea Spatial Plan Ordinance, 2009), the standards set out under 6.4.3.1 (Impact assessment of area N-5) apply analogously.

All three offshore wind farms "Amrumbank West", "North Sea East" and "Seawind South/East" have been in operation since 2016. The results of monitoring in accordance with the Standard Investigation Concept also uniformly and unambiguously showed the extremely pronounced avoidance behaviour of divers in relation to wind farms at all three wind farms. Statistically significant decreases in abundance at distances of more than 10 km, starting from the edge of the respective wind farm, were found (Planning Association for Environmental Planning for Offshore Wind Farm 2015, IBL environmental planning, et al. 2016a, IBL Umweltplanung et al. 2017b).

The results of the monitoring were included in the analysis of the cumulative effects by the Research and Technology Centre. The calculated total habitat loss of 5.5 km also applies to these three wind farms. This is subject to the purely statistical assumption that there are no divers in appreciable numbers up to a distance of 5.5 km from an offshore wind farm. A statistically significant decrease in abundance was found up to 10 km away in the current Research and Technology Centre study. For the statistically significant decrease in abundance, this is not a total avoidance but a partial avoidance with increasing diver densities up to 10 km away from a wind farm. This shows that the diver population has shifted to the central part of the main concentration area (Garthe et al. 2018).

Based on the new findings from the cumulative assessment of the impact on divers, area N-4 was assessed in the context of defining a subsequent-use plan. Monitoring of the impact that operation has on loons will continue in the coming years.

Monitoring and possible mitigation measures will be prescribed as part of the implementation of the individual projects and are not part of the plan.

The results of the monitoring will be analysed and evaluated cumulatively when the plan is updated.

An extension of area N-4 for the use of offshore wind energy beyond the priority area established in the maritime spatial planning for the German EEZ in the North Sea (EEZ North Sea Spatial Plan Ordinance 2009) is therefore excluded for reasons of ensuring species conservation for the divers species group. The possible subsequent use of the area will be reassessed based on the results of continued monitoring in the Site Development Plan update.

As a result, the implementation of the plan with regard to the N-4 area, taking into account the preventive measures introduced since 2009, the subsequent-use status currently under assessment, as well as the avoidance and mitigation measures implemented, the possibility of considerable impairment of the conservation objectives and protective aims of area II of the "Sylt Outer Reef – Eastern German Bight" nature conservation area is excluded with the necessary certainty.

6.3.2.2.2 Impact assessment of the Site Development Plan for area N-5 and the associated sites and platforms with regard to protected bird species

The present plan defines area N-5 and related platforms.

According to the current state of knowledge from the monitoring of the Natura 2000 sites on behalf of the Federal Agency for Nature Conservation and from environmental impact studies and monitoring of offshore wind farms, among the bird species listed in section 5 subsection 1 SGNSylV, the two diver species, namely the red-throated diver (Gavia stellata) and the black-throated diver (Gavia arctica), are considered particularly sensitive to disturbance from offshore wind farms. Red-throated divers account for 90% of all diver sightings in the entire EEZ of the North Sea and especially in the area of the nature conservation area.

The red-throated diver is a species with a long life span that reaches reproductive maturity relatively late. It has a very low reproductive potential and a very high mortality rate of young birds. The relatively low mortality of adult individuals cannot counteract the relatively low natural reproductive success. Red-throated divers are therefore highly sensitive in terms of their reproduction strategy and long lifespan.

As already described in chapter 4.12, an area in the German EEZ of the North Sea that serves as a feeding and resting habitat for most divers in the German EEZ in spring was identified back in 2009 (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2009). The identified main spring concentration area of divers in the German EEZ of the North Sea has an area of 7,036 km² and represents the natural and functional unit of the local population of divers in the German EEZ of the North Sea. Area II of the "Sylt Outer Reef – Eastern German Bight" nature conservation area with an area of 3,135 km² is part of this main concentration area for divers. The population of divers in area II of the nature conservation area is thus part of the local population of divers in the German EEZ of the North Sea.

The restriction on the use of offshore wind energy within this area associated with the definition of the main concentration area of the divers represents a preventive measure of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2009) aimed at counteracting considerable adverse impacts of the avoidance behaviour of the divers in relation to the offshore wind farms with regard to the protective aims of area II of the "Sylt Outer Reef – Eastern German Bight" nature conservation area. In the evaluation carried out by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety in 2009, the impacts of all offshore wind farms within the priority area "Northern Helgoland" (EEZ North Sea Spatial Plan Ordinance, 2009) and of the offshore wind farms "Butendiek", "Dan Tysk", "Sandbank" and "Northern Ground" already approved at that time were taken into account.

The rule established by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2009) is intended to ensure that divers displaced by avoiding sub-habitats in area II of the nature conservation area can find sufficient undisturbed and equivalent feeding and resting habitats as alternatives. The measure to restrict the use of offshore wind energy to only certain sites of the main concentration area excludes the possibility of significant impairment of the protective aims of the nature conservation area with the necessary certainty.

The offshore wind farm "Butendiek", which is in operation, is currently one of the most important existing impacts for divers in area II of the "Sylt Outer Reef – Eastern German Bight" nature conservation area. However, the existing impacts of area II also include the remote effects of the "Dan Tysk" and "Sand Bank" offshore wind farms in the immediate vicinity. The remote effects of the offshore wind farms "Amrumbank West", "North Sea East" and "Seawind South/East", which are also adjacent to the nature conservation area, are discussed under 6.3.2.3. In this context, it is important to note that all the offshore wind farms mentioned here are not to be assessed individually in terms of their impact on the nature conservation area. It is instead necessary to assess the effects of the offshore wind farms mentioned above and the cumulative effects of the plan with regard to possible impacts on the conservation objectives and protective aims of the nature conservation area. The effects of projects inside and outside the area of the nature conservation area must be taken into account in the assessment of the significance as defined in Art. 6 (4), Habitats Directive (Natura 2000 site management). The provisions of Article 6 of the Habitats Directive 92/43/EEC, 2018, Note of the European Commission. legal case, C-142/16, marg. no. 29).

The above-mentioned offshore wind farms have been in operation within the main concentration area since 2014. The results of monitoring in accordance with the Standard Investigation Concept also uniformly and unambiguously showed the extremely pronounced avoidance behaviour of divers in relation to offshore wind farms for all projects mentioned. Statistically significant decreases in abundance at distances of more than 10 km, starting from the edge of the respective wind farm, were found for all of them (BioConsult SH & Co.KG 2017, BioConsult SH & Co.KG 2018, Institute for Applied Ecosystem Research 2017, Institute for Applied Ecosystem Research 2018, Planning Association for Environmental Planning for Offshore Wind Farm 2015, IBL environmental planning et al. 2016a, IBL Umweltplanung et al. 2017b).

As part of a commission from the Federal Maritime and Hydrographic Agency and Federal Agency for Nature Conservation, the Research and Technology Centre Büsum of the University of Kiel (FTZ) has analysed all data from research and monitoring from the first years of the operating phase, including data from all environmental impact studies and construction phases of the offshore wind farms in the German EEZ of the North Sea with regard to cumulative effects on the divers (Garthe et al. 2018). The Research and Technology Centre study clearly shows that the avoidance behaviour of divers in relation to wind farms is far more pronounced than originally assumed by the Federal Ministry for the Environment, Nature Conservation, Construction and Nuclear Safety (2009). Whereas earlier decisions for individual approval procedures were based on an average deterrence distance of 2 km (defined as a complete avoidance of the wind farm area including a buffer zone of 2 km around a wind farm (see Federal Ministry for the Environment, Nature Conservation and Nuclear Safety 2009)) for divers, the current findings show that this deterrence distance, known as the calculated total habitat loss, has significantly increased to an average of 5.5 km. The calculated total habitat loss of 5.5 km is used to quantify the habitat loss, similar to the previous deterrence distance of 2 km. This is subject to the purely statistical assumption that there are no divers in appreciable numbers at a distance of up to 5.5 km from an offshore wind farm. A statistically significant decrease in abundance up to 10 km away was found in the current Research and Technology Centre study. For the statistically significant decrease in abundance, this is not a total avoidance but a partial avoidance with increasing diver densities up to 10 km away from a wind farm. This shows that the diver population has shifted to the central part of the main concentration area (Garthe et al. 2018).

Assessment of the identified adverse effects of operation of offshore wind farms on the conservation status of the local divers population as defined in section 44 subsection 1 no. 2 of the Federal Nature Conservation Act (ban on disturbance), based on the results of the cumulative assessment of the habitat loss, has shown that measures are necessary to ensure that no significant disturbance will occur in the future.

At the same time, from a species conservation standpoint, the measures undertaken in the plan ensure that the possibility of significant impairment of the conservation objectives and protective aims of area II of the nature conservation area can be ruled out.

Through a series of rules, by way of exclusion or assessment of the areas for subsequent use, the present plan ensures that the possibility of significant impairment of the conservation objectives and protective aims of area II of the "Sylt Outer Reef – Eastern German Bight" nature conservation area can be excluded. The plan thus adopts measures which go beyond the preventive measure of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2009) already in force restricting the use of offshore wind energy within the main concentration area of divers.

The exclusion of the "Butendiek" wind farm from subsequent use, for example, represents an important reduction measure in the plan to preserve and restore the natural quality of habitats with their ecological functions, their integrity and spatial interrelationships, which are particularly important for divers.

At the same time, the exclusion of site N-5.4, which is the subject of assessment in the (preliminary) drafts of the Site Development Plan, is an important avoidance measure of the plan to preserve and restore the qualitative and quantitative populations of divers with the aim of achieving a favourable conservation status. The necessity of this measure already became apparent during the evaluation of the cumulative effects of the offshore wind farms in operation to be able to exclude with the necessary certainty a significant disturbance of the local population of the divers, which also includes the populations of divers from area II of the nature conservation area as defined in section 44, subsection 1, no. 2 of the Federal Nature Conservation Act. Even if site N-5.4, as outlined in the (preliminary) drafts of the Site Development Plan, lies outside area II of the nature conservation area, it is not possible to rule out the possibility that, through its implementation, the identified adverse effects from the cumulative effects of an additional offshore wind farm within the equivalent alternative habitat (main concentration area) of the divers may ultimately lead to significant impairment of the protective aims of area II of the nature conservation area.

Finally, the plan assesses the two parts of site N-5 with the "Dan Tysk" and "Sand Bank" offshore wind farms for subsequent use. Monitoring of the impact that operation has on loons will continue in the coming years.

Monitoring and possible mitigation measures of the existing projects will be prescribed as part of the implementation of the individual projects and are not part of the plan.

The results of the monitoring will be analysed and evaluated cumulatively when the plan is updated.

As a result, it can be said that with regard to area N-5 and taking into account the preventative measure introduced in 2009 and the avoidance and mitigation measures implemented here, the possibility of significant impairment of the protective aims and conservation objectives of area II of the "Sylt Outer Reef – Eastern German Bight" nature conservation area is excluded with the necessary certainty through the Site Development Plan.

6.3.2.2.3 Impact assessment of the Site Development Plan for areas N-11 and N-13 and the associated sites and platforms with regard to protected bird species

Areas N-11 and N-13 are located at the edge of the main diver concentration area in the German EEZ of the North Sea.

Areas N-11 and N-13 are not suitable for divers due to their depth and hydrographic conditions. According to the current state of knowledge, the two areas N-11 and N-13 are of minor importance as alternative habitats for divers.

In the results, the possibility of significant impairment of the conservation objectives of area II of the "Sylt Reef Ground – Eastern German Bight" nature conservation area can be ruled out with the necessary certainty through implementation of the plan with regard to areas N-11 and N-13.

6.3.2.2.4 Impact assessment of the Site Development Plan for areas N-1 to N-3, N-6 to N-10 and N-12 and the associated sites and platforms with regard to protected bird species

According to the current state of knowledge, these areas have no significance with regard to the occurrence of divers in area II of the "Sylt Outer Reef – Eastern German Bight" nature conservation area due to their distance.

The possibility of significant impairment of the conservation objectives and protective aims of area II of the "Sylt Outer Reef – Eastern German Bight" nature conservation area by the implementation of projects in areas N-1 to N-3, N-6 to N-10 and N-12 can be ruled out due to the distance.

6.3.2.2.5 Impact assessment of the Site Development Plan for submarine cable systems with regard to protected bird species

The assessment of the potential impact of the plan has shown that the installation and operation of submarine cable systems will not have significant adverse effects on bird species in the vicinity of the cable routes. The possibility of any impairment of the conservation objectives of the "Sylt Outer Reef – Eastern German Bight" nature conservation area as a result of the laying and operation of submarine cables can be ruled out with the necessary certainty, assuming such is done in compliance with the planning principles of this plan and that appropriate measures are carried out during implementation.

In the results, considerable impairment of the conservation objectives of area I of the "Sylt Reef Ground – Eastern German Bight" nature conservation area can be ruled out with the necessary certainty through implementation of the plan and if proper prevention and mitigation measures are carried out.

6.3.3 Impact assessment pursuant to section 34 subsection 1 of the Federal Nature Conservation Act in conjunction with Art. 6 (3) of the Habitats Directive and in accordance with section 5 subsection 7 of the Ordinance on the Establishment of the Nature Conservation Area "Dogger Bank"

An assessment of the implications pursuant to section 34 subsection 2 to 5 of the Federal Nature Conservation Act must be carried out if a preliminary assessment pursuant to section 34 subsection 1 of the Federal Nature Conservation Act concludes that significant impairment of a protected area is a serious concern.

The present plan defines areas, platforms and connection systems within a minimum distance of more than 100 km from the "Dogger Bank" nature conservation area (EU code: DE 1003-301). This was established by the ordinance of 22 September 2017 ("Ordinance on the Establishment of the Nature Conservation Area "Dogger Bank", Federal Law Gazette I, I S, 3400"). Two interconnectors crossing the "Dogger Bank" nature conservation area are planned; see chapter 6.2.3.1.

Pursuant to section 34 subsection 1 of the Federal Nature Conservation Act and section 5 subsection 6 NSGDgbV, projects must be reviewed for their implications for the protective aims of a protected area prior to their approval or implementation if, individually or in conjunction with other projects or plans, they are likely to have a significant impact on the nature conservation area and do not directly serve the administration of the area.

The Federal Maritime and Hydrographic Agency is responsible for the assessment of the implications according to section 34 of the Federal Nature Conservation Act and section 5 subsection 7 NSGDgbV.

6.3.3.1 Impact assessment of the Site Development Plan for areas, sites and associated platforms with regard to marine mammals

The assessment of the plan's implications in connection with the definition of areas, sites and associated platforms is based on the conservation objectives of the "Dogger Bank" nature conservation area. According to section 3, subsection 1 NSGDgbV, the conservation objective is achieving the protective aims of the Natura 2000 site. Pursuant to section 3 subsection 2 no. 2 NSGDgbV, the conservation and restoration of the specific ecological values and functions of the area, in particular the populations of harbour porpoises and harbour seals and their habitats and natural population dynamics are to be protected.

Finally, under section 5 subsection 1 to subsection 4 NSGDgbV to ensure the survival and reproduction of the marine mammal species of harbour porpoise and harbour seals listed in section 3 subsection 2 NSGDgbV of the Annex II to the Habitats Directive (92/43/EWG) and the preservation and restoration of their habitats.

Conservation and restoration:

- subsection.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 and reproductive fitness, taking into account natural population dynamics and genetic exchanges with populations outside the area,
- subsection 2: of the area as a largely undisturbed habitat unaffected by local pollution for harbour porpoises and harbour seals, and especially as a significant feeding, migration, breeding and rearing habitat for harbour porpoises in the central area of the North Sea.
- subsection 3: of unfragmented habitats and the possibility of migration of the species of harbour porpoises and harbour seals within the German North Sea and to Dutch, British and Danish waters and
- subsection 4: of the essential organisms serving as food resources for harbour porpoises and harbour seals, in particular their natural population densities, age-group distributions and distribution patterns.

All areas, sites and platforms defined in the present plan are within a minimum distance of more than 100 km from the "Dogger Bank" nature conservation area.

An assessment of the implications pursuant to section 34 of the Federal Nature Conservation Act is not required due to the distance to the nature conservation area.

The possibility of any impairment of the protective aims of the "Dogger Bank" nature conservation area as a result of the definition of areas, sites and associated platforms in the present plan can be ruled out with certainty.

6.3.3.2 Impact assessment of the Site Development Plan for submarine cable systems with regard to marine mammals

Two Interconnectors are planned through the "Dogger Bank" nature conservation area. The assessment of the potential impact of the Site Development Plan has shown that the installation and operation of submarine cable systems will not have significant adverse effects on marine mammals in the vicinity of the cable routes. The possibility of any impairment of the conservation objectives of the "Dogger Bank" nature conservation area as the result the laying and operation of submarine cables can be ruled out with the necessary certainty, assuming that suitable measures are carried during implementation.

In the results, the possibility of significant impairment of the conservation objectives of the nature conservation area "Dogger Bank" can be ruled out by with the necessary certainty through implementation of the plan and if proper prevention and mitigation measures are carried out.

6.4 Natura 2000 areas outside the German EEZs

In addition, the assessment of the implications also takes into account the remote effects of the rules defined within the EEZ on the protected areas in the adjacent 12 nautical mile zone and the adjacent waters of the neighbouring states. This also affects the assessment and consideration of functional relationships between the individual protected areas and the coherence of the network of protected areas pursuant to section 56 subsection 2 of the Federal Nature Conservation Act since the habitat of some target species (e.g. avifauna, marine mammals) can extend over several protected areas due to their large radius of activity.

Specifically, the protected areas "Lower Saxon Wadden Sea National Park" and the EU bird sanctuary "Lower Saxon Wadden Sea and adjacent coastal waters" in Lower Saxon coastal waters, the "Schleswig-Holstein Wadden Sea National Park", the "Ramsar Area Schleswig-Holstein Wadden Sea and adjacent coastal areas", the FFH area "Steingrund" and the "Helgoland seabird sanctuary" in Schleswig-Holstein coastal waters, and the Natura 2000 site "Southern North Sea" in the Danish EEZ, the Dutch bird sanctuary "Friese Front" and the Dutch FFH area "Dogger Bank" are taken into account.

The conservation objectives and protective aims for the Natura 2000 sites outside the EEZ have been taken from the following documents:

- FFH-Gebiet "Nationalpark Niedersächsisches Wattenmeer": § 2 i.V.m. Anlage 5 Gesetz über den Nationalpark "Niedersächsisches Wattenmeer" (NWattNPG) vom 11. Juli 2001 (FFH area "Lower Saxon Wadden Sea National Park": section 2 in conjunction with Annex 5 of the Law on the Wadden Sea National Park in Lower Saxony (NWattNPG) from 11 July 2001) (http://www.lexsoft.de/cgi-bin/lexsoft/niedersachsen_recht.cgi?chosenIndex=Dummy_nv_6&xid=173529,3)
- EU-Vogelschutzgebiet "Niedersächsisches Wattenmeer und angrenzendes Küstenmeer": Natura2000-Gebiete der Tideweser in Niedersachsen und Bremen (EU bird sanctuary "Lower Saxony Wadden Sea and adjacent coastal sea": Natura 2000 sites of the Tideweser in Lower Saxony and Bremen) (http://www.umwelt.bremen.de/sixcms/medi

a.php/13/Fachbeitrag-1_Natura%202000_Teil%203.pdf)

- FFH-Gebiet "Nationalpark Schleswig-Holsteinisches Wattenmeer und angrenzende Küstengebiete": Erhaltungsziele für das FFH-Vorschlagsgebiet DE-0916-391 "NTP S-H Wattenmeer und angrenzende Küstengebiete" (FFH area "Schleswig-Holstein Wadden Sea National Park and adjacent coastal areas": Conservation objectives for the FFH proposed site DE-0916-391 "NTP S-H Wadden Sea and adjacent coastal areas") (http://www.umweltdaten.landsh.de/public/natura/pdf/erhaltungsziele/DE-0916-391.pdf)
- EU-Vogelschutzgebiet "Ramsar-Gebiet S-H Wattenmeer und angrenzende Küstengebiete": Erhaltungsziele für das Vogelschutzgebiet DE- 0916-491 "Ramsar-Gebiet S-H Wattenmeer und angrenzende Küstengebiete" (EU bird sanctuary "Ramsar area S-H Wadden Sea and adjacent coastal areas": conservation objectives for the bird sanctuary 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**":** Erhaltungsziele für das Vogelschutzgebiet DE-1813-491 "Seevogelschutzgebiet Helgoland" ("Seabird sanctuary Helgoland: conservation objectives for the bird sanctuary DE-1813-491 "Seabird sanctuary Helgoland") **(**http://www.umweltdaten.landsh.de/public/natura/pdf/erhaltungsziele/DE-1813-491.pdf)
- FFH-Gebiet "Steingrund": Erhaltungsziele für das als Gebiet von gemeinschaftlicher Bedeutung benannte Gebiet DE 714-391 "Steingrund" (FFH site "Steingrund": conservation objectives for the site designated as a site of Community importance DE 714-391 "Steingrund") (www.umweltdaten.landsh.de/public/natura/pdf/erhaltungsziele/DE-1714-391.pdf)
- Dänemark: FFH- und Vogelschutzgebiet "Sydlige Nordsø": EUNIS Factsheet (Denmark: FFH and bird sanctuary "Sydlige Nordsø": EUNIS Factsheet) (http://eunis.eea.europa.eu/sites/DK00VA347)
- Niederlande: Vogelschutzgebiet "Friese Front": EUNIS Factsheet (Netherlands: bird sanctuary "Friese Front": EUNIS Factsheet) (https://eunis.eea.europa.eu/sites/NL2016166)
- Niederlande: FFH-Gebiet "Doggersbank": EUNIS Factsheet (Netherlands: bird sanctuary "Dogger Bank": EUNIS Factsheet) (https://eunis.eea.europa.eu/sites/NL2008001).

In addition, under Art. 12 of the Habitats Directive, for species listed in Annex IV to the Habitats Directive, the EU Member States shall take the necessary measures in and outside of protected areas to establish a strict system of protection for these species in their natural distribution range. These include all whale species according to the Habitats Directive. Parts of the feeding habitat are to be preserved by the FFH areas.

Apart from the effects of the plan within the EEZ, this assessment of the implications explicitly examines only possible remote effects of the areas, sites, platforms and submarine cable routes that are planned in the EEZ in protected areas in adjacent areas. The planned areas, sites, platforms and submarine cable routes are located sufficiently far away from the protected areas in coastal waters, so no significant effects on these protected areas can be assumed in this respect. However, this consideration is not made with regard to routes in coastal waters, which are connected to the gates provided for in the Site Development Plan. This assessment is the subject of the coastal states' environmental reports on the respective Spatial Plans or secondary procedures.

With regard to seabirds and resting birds, the Danish bird sanctuary "Sydlige Nordsø", which is directly adjacent to the German EEZ to the north and has a high number of divers, should be taken into account when assessing possible significant impacts on protected areas outside the German EEZ. The non-designation of area N-5.4 counteracts a possible impairment of the Danish bird sanctuary, including the presence of sea divers there.

6.5 Results of the assessment of the implications

As a result, the possibility that implementation of the Site Development Plan will significantly impair the conservation objectives of the "Borkum Reef Ground" nature conservation areas, the conservation objectives of the "Sylt Outer Reef – Eastern German Bight" nature conservation area and the conservation objectives of the "Dogger Bank" nature conservation area, and of protected areas outside the German EEZ can be ruled out with the necessary certainty provided that avoidance and mitigation measures for FFH habitat types, marine mammals, avifauna and other groups of animals protected under the Habitats Directive are carried out.

It should be noted here that the FFH assessment of the implications carried out here could not assess project-specific properties, which were only specified and defined in the context of planning approval procedures by project developers. The assessment of the implications is therefore carried out more concretely as part of planning approval procedures for the respective project with the aim of deriving and defining the necessary avoidance and mitigation measures at project level.

The possibility of significant impairment of the FFH habitat types "reefs" and "sandbanks which are slightly covered by sea water all the time" can be excluded according to the current state of knowledge, even with cumulative assessment of the plan and already existing projects for the nature conservation areas "Borkum Reef Ground", "Sylt Outer Reef – Eastern German Bight" and "Dogger Bank".

7 Overall plan evaluation

In summary, with regard to the planned areas and sites, platforms and submarine cable routes, the effects on the marine environment will be minimised as far as possible by means of orderly, coordinated overall planning of the Site Development Plan. By adhering strictly to prevention and mitigation measures, in particular for noise mitigation during the construction phase, considerable effects can be prevented by implementing the planned sites, areas and platforms. No areas or sites have been defined in the nature conservation sites. In addition, site N-5.4 in the main concentration area of the divers to the west of Sylt, as described in the (preliminary) drafts, has not been designated and areas N-4 and N-5 will be assessed for possible subsequent use.

The laying of submarine cable systems can be made as eco-friendly as possible, e.g. by bypassing nature conservation areas and protected biotopes and by choosing a laying method that is as unobtrusive as possible. The planning principle for sediment warming should ensure that significant negative effects of cable heating on benthic communities are prevented. Preventing crossings between submarine cable systems as far as possible also serves to prevent negative effects on the marine environment, in particular on the factors Soil, Benthos and Biotopes. Given the above descriptions and assessments, the Strategic Environmental Assessment concludes that, with regard to possible interrelationships, no significant effects on the marine environment within the investigation area are to be expected from the planned rules based on current knowledge and the comparatively abstract level of technical planning. The potential effects are frequently small-scale and mostly short-term, as they are limited to the construction phase. To date, sufficient scientific knowledge and consistent evaluation methods are lacking for cumulative assessment of the effects on individual factors such as bat migration. Therefore, these effects cannot be assessed conclusively within the framework of the present SEA or are subject to uncertainties and either need to be assessed more closely within the framework of subsequent planning stages or the update to the Site Development Plan.

8 Measures to prevent, mitigate and offset significant negative effects of the Site Development Plan on the marine environment

8.1 Introduction

Pursuant to section 40 subsection 2 UVPG, the environmental report includes a description of the planned measures to prevent, mitigate and, as far as possible, compensate for significant adverse environmental effects resulting from implementation of the plan. In principle, the Site Development Plan will take marine environment concerns into account more effectively when expanding power generation by means of offshore wind turbines and the corresponding connecting lines. The rules of the Site Development Plan will prevent negative effects on the development of the state of the environment of the North Sea EEZ. This is due in particular to the fact that there is always a need to expand offshore wind energy and the corresponding connecting lines and that the corresponding infrastructure (wind farms, platforms and submarine cable systems) would have to be created even without the Site Development Plan (see chap. 3). If the plan were not implemented, the uses would, however, develop without the space-saving and resource-conserving steering and coordination effect of the Site Development Plan.

Moreover, the rules of the Site Development Plan are subject to a continuous optimisation process, as the knowledge obtained on a rolling basis within the framework of the SEA and the consultation process is taken into account when the plan is compiled.

While individual prevention, mitigation and compensation measures may begin even at the planning level, others only come into play at the specific implementation stage and are regulated there in the individual approval procedure according to the project and location. With regard to planning prevention and mitigation measures, the Site Development Plan defines spatial and textual rules which, according to the environmental protection objectives set out in chapter 3, serve to prevent or mitigate significant negative effects in the marine environment due to implementation of the Site Development Plan. This mainly concerns

- consideration of nature conservation areas and legally protected biotopes
    - exclusion effect of wind turbines in nature conservation areas,
    - exclusion effect of platforms in nature conservation areas,
    - the principle of laying submarine cable systems outside these areas as far as possible,
- exclusion or assessment of the definition of areas and sites in the main concentration area of the divers
- as little land usage as possible, ensured by the planning principles
    - economic area use when arranging wind turbines,
    - maximum possible bundling of submarine cable routes in the sense of parallel routing,
    - prevention of cable and pipeline crossings,
- the planning principle for noise mitigation,
- the planning principle for sediment warming,
- reduction of scour protection measures to a minimum so as to prevent having to introduce artificial hard substrate,

- rules for the dismantling of structural installations, and
- consideration of best environmental practice in accordance with the OSPAR Convention and the state of the art.

The measures listed below serve to prevent and mitigate insignificant and significant negative effects in the specific implementation of the Site Development Plan. These mitigation and prevention measures are specified and ordered by the competent licensing authority at project level for the planning, construction and operation phases.

8.2 Areas and sites for offshore wind turbines

The following measures to prevent and mitigate significant and insignificant negative environmental effects must be taken into account in the specific planning and construction of wind turbines:

- When installing foundations, suitable measures must be implemented to ensure that noise emissions (sound pressure SEL_{05}) at a distance of 750 m does not exceed 160 decibels (dB re 1 μPa²s) and the peak sound pressure level does not exceed 190 decibels (dB re 1 μPa).
- Adherence to pile-driving times, including aversive conditioning measures, of no more than 180 minutes during the insertion of monopiles and no more than 140 minutes per pile for jacket structures.
- Monitoring activities during the construction phase, in particular by recording the underwater noise level during the installation of foundations. Monitoring of noise level and compliance with limits must be carried out by an accredited facility. The suitability of the measuring equipment is to be demonstrated by accreditation in accordance with DIN EN ISO/IEC 17025 with regard to ISO 18406:2017 and DIN SPEC 45653:2017.
- Noise mitigation measures: use of the relevant best available method according to the state of the art in science and technology in order to reduce the level of underwater noise so as to comply with applicable noise protection specifications during the installation of foundation piles, e.g. large bubble curtains, hydro silencers or sheathing. These noise protection measures must be specified in detail in the individual approval procedures for specific locations and installations.
- Adaptation of the pile-driving process to location- and project-specific conditions by control of the pile-driving energy and impact frequency
- Noise prevention measures: use appropriate methods to prevent killing and injuring fauna near the pile-driving site:
    - Use of suitable deterrent devices such as the FaunaGuard system or, in special cases, "pingers" and "seal scarers".
    - "Soft-start procedure": delaying the increase of pile-driving energy should allow fauna in the vicinity of the pile-driving site to move away from the construction site.
- Coordination of pile-driving work for various projects in order to minimise overall noise output times.
- Consideration of the noise protection concept of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2013).
- Assessment of alternative, low-noise foundation forms, such as "suction buckets". The environmental impact of alternative forms of foundation must always be assessed with regard to any additional

significant effects on the marine environment, in particular also from the introduction of continuous noise.

- Reduction and bundling of shipping traffic or other ship-related measures for construction and operation of wind turbines, and the associated acoustic and visual impairments, to a minimum through optimal construction and time planning.

- Ensuring that no preventable emissions of pollutants, noise or light occur during the construction or operation of the installation in accordance with the state of the art.
- Lighting that is as compatible as possible with nature during operation of the installations in order to reduce attraction as far as possible, taking into account the requirements of safe shipping and air traffic and occupational safety, e.g. switching obstruction lighting on and off as required, selection of suitable lighting intensities and spectra or lighting intervals.
- Restriction of the introduction of hard substrate to a minimum.
- Use of low-pollution paints.
- Use of traffic safety vehicles during the construction and commissioning phases in order to prevent collisions
- Correct disposal of oil residues from machinery, faeces, packaging, waste and wastewater on land. Preparation of a "waste concept" for construction and operation.
- Compilation of emergency plans, including for accidents involving water-polluting substances during the construction and operation phases.
- If, during planning or installation of plants, so far undiscovered ordnance is found on the seabed, corresponding protective measures must be taken.
- Monitoring of possible effects on the marine environment due to the construction or operation of the installations by means of mandatory ecological monitoring during the construction and operation phase in accordance with StUK 4. Continuation of the operational monitoring beyond the period of 3 - 5 years after commissioning of a wind farm, as specified in the Standard "Investigation into the impacts of offshore wind turbines" (StUK 4), may be technically necessary with regard to project-related or area-specific conditions to an appropriate extent. The decision on the necessity and scope of continued operational monitoring is expressly reserved by Federal Maritime and Hydrographic Agency as the enforcement and monitoring authority.

8.3 Platforms

The following measures to prevent and mitigate significant and insignificant negative environmental effects must be taken into account in the specific planning and construction of platforms (converter platforms, collector platforms, transformer platforms and residential platforms):

- When installing foundations, suitable measures must be implemented to ensure that noise emissions (sound pressure SEL_{05}) at a distance of 750 m does not exceed 160 decibels (dB re 1 μPa²s) and the peak sound pressure level does not exceed 190 decibels (dB re 1 μPa).

- Adherence to pile-driving times, including aversive conditioning measures, of no more than 180 minutes during the insertion of monopiles and no more than 140 minutes per pile for jacket structures.

- Monitoring measures during the construction phase, in particular by recording the underwater noise level when foundations are being installed. Monitoring of noise level and compliance with limits must be carried out by an accredited facility. The suitability of the measuring equipment is to be demonstrated by accreditation in accordance with DIN EN ISO/IEC 17025 with regard to ISO 18406:2017 and DIN SPEC 45653:2017.

- Noise mitigation measures: use of the relevant best available method according to the state of the art in science and technology in order to reduce the level of underwater noise so as to comply with applicable noise protection specifications during the installation of foundation piles, e.g. large bubble curtains, hydro silencers or sheathing. These noise protection measures must be specified in detail in the individual approval procedures for specific locations and installations.
- Adaptation of the pile-driving process to location- and project-specific conditions by control of the pile-driving energy and impact frequency
- Noise prevention measures: use appropriate methods to prevent killing and injuring fauna near the pile-driving site:
    - Use of suitable deterrent devices such as the FaunaGuard system or, in special cases, "pingers" and "seal scarers".
    - "Soft-start procedure": delaying the increase of pile-driving energy should allow fauna in the vicinity of the pile-driving site to move away from the construction site.
- Coordination of pile-driving work for various projects in order to minimise overall noise output times.
- Consideration of the noise protection concept of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2013).
- Assessment of alternative, low-noise foundation forms for platforms, such as "suction buckets" or gravity foundations. The environmental impact of alternative forms of foundation must always be assessed with regard to any additional significant effects on the marine environment, in particular due to the introduction of continuous noise.
- Reduction of shipping traffic for construction and operation of platforms, and the associated acoustic and visual impairments, to a minimum by optimal construction and time planning.
- Ensuring that no preventable emissions of pollutants, noise or light occur during the construction or operation of the installation in accordance with the state of the art.
- Lighting that is as compatible as possible with nature during operation of the platforms in order to reduce attraction as far as possible, taking into account the requirements of safe shipping and air traffic and occupational safety, e.g. switching obstruction lighting on and off as required, selection of suitable lighting intensities and spectra or lighting intervals.
- Restriction of the introduction of hard substrate to a minimum.
- Use of low-pollution paints.
- Use of traffic safety vehicles during the construction and commissioning phases in order to prevent collisions.
- Correct disposal of oil residues from machinery, faeces, packaging, waste and wastewater on land. Preparation of a "waste concept" for construction and operation.
- Compilation of emergency plans, including for accidents involving water-polluting substances during the construction and operation phases.
- If, during planning or installation of platforms, so far undiscovered ordnance is

found on the seabed, corresponding protective measures must be taken.

8.4 Submarine cable systems (DC and AC Subsea Cable Systems)

Measures for prevention and mitigation must be taken into account as early as the route planning and technical design stages (see 8.1). The magnetic field development of the cable systems is kept to a minimum by the use of HVDC technology as specified in the Site Development Plan and the cable configurations specified in accordance with the state of the art. The planning principle for sediment warming should ensure compliance with the "2K criterion", i.e. a maximum permissible temperature increase of 2 K at a sediment depth of 20 cm.

Moreover, the following measures that help to prevent and mitigate environmental effects are to be implemented in the specific implementation of the individual projects:

- Relocation outside nature conservation areas and known occurrences of protected biotope structures, if possible
- Selection of the shortest possible route
- Bundled cable laying
- Optimisation of route selection within the framework of fine routing in order to prevent and not effect known occurrences of particularly sensitive biotopes as far as possible in accordance with section 30 of the Federal Nature Conservation Act
- Use of laying methods that protect the soil as much as possible for installation of the cable systems, depending on sediment conditions and water depths and taking into account the required minimum coverage
- Use of cable types that develop electric and magnetic fields that are as low as possible
- Use of materials in cable systems that are as eco-friendly as possible
- Reduction of intersections to the required minimum
- Use of inert, natural materials for filling and intersections that become necessary
- If, during planning or installation of submarine cable systems, so far undiscovered ordnance is found on the seabed, corresponding protective measures must be taken.

The aim is to implement the following measures with a view to achieving the most eco-friendly design possible:

- Investigation and description of the effects of platforms and submarine cable systems on the marine environment as part of a monitoring process, including monitoring of the cover during the operating phase of the cables;
- Evaluation of the monitoring results in respect of cumulative effects or interrelationships of various uses;
- Consideration of the monitoring results within the framework of the update, i.e. experience from implementation of the projects is used to continuously improve mitigation and prevention measures.

9 Investigated alternatives

According to Art. 5 subsection 1 sentence 1 of the SEA Directive in conjunction with the criteria in Annex I of the SEA Directive and section 40 subsection 2 no. 8 of the Environmental Impact Assessment Act, the environmental report contains a brief description of the reasons for choosing the reasonable alternatives assessed. The reasonable alternatives under consideration are explained below. Essentially, different types of alternatives can be considered for an assessment of alternatives; in particular strategic, spatial or technical alternatives. The prerequisite is always that these are reasonable or can be seriously considered.

Thus not all conceivable alternatives need to be assessed. However, it is no longer sufficient to identify, describe and evaluate only those alternatives that "seriously offer" or "impose" themselves. The obligation to investigate thus extends to all alternatives that "are not obviously ... remote" (Landmann/Rohmer, 2018). Assessment of alternatives does not explicitly require the development and assessment of particularly eco-friendly alternatives. Rather, the "reasonable" alternatives in the above sense should be presented in a comparative manner with regard to their environmental effects, so that consideration of environmental concerns becomes transparent when deciding on the alternative to be pursued (S. Balla, 2009).

At the same time, the effort required to identify and assess the alternatives under consideration must be reasonable. This means that the greater the expected environmental effects and hence the need for planning conflict resolution, the more likely it is that comprehensive or detailed investigations will be required.

By way of example, Annex 4 no. 2 UVPG refers to the assessment of alternatives with regard to the design, technology, location, size and scope of the project, but explicitly refers only to projects. Conceptual/strategic design, the spatial location and technical alternatives therefore play a part at the planning level.

In principle, it should be noted that preliminary examination of possible and conceivable alternatives is already inherent in all rules in the form of standardised technical and planning principles. As can be seen from the justification of the individual planning principles, in particular those relating to the environment – such as, for example, routing that is as bundled as possible and implementation that is as free from crossings as possible – the principle in question is already based on consideration of possible public concerns and legal positions, so that a "preliminary assessment" of possible alternatives has already been carried out. There are already a large number of different uses and legally protected concerns in the EEZ. A "Regulation on Spatial Planning in the German EEZ in the North Sea" of 21 September 2009, which defines objectives and principles, also exists in order to regulate the usage interests within the North Sea EEZ. An overall assessment of the uses and functions in the EEZ has already been carried out as part of the preparation of the Spatial Plan. The objectives and principles of the Spatial Plan have largely been adopted in the Site Development Plan and are being reviewed and weighed against the specific regulatory issues of the concerns and rights presented in this procedure.

Possible reasonable alternatives in detail:

9.1 Zero alternative

The zero alternative, i.e. not implementing the Site Development Plan, is not a sensible alternative since the lack of coordination would probably lead to greater area use, more cable intersections and thus additional environmental impacts (see chapter 3).

Although it is not possible to quantify the number of additional intersections that will be created and the additional space that will be required as a result, it is clear from the defined rules that a considerable number of intersections can no longer be avoided at this planning stage due to the existing system of individual connections. For future projects, the aim is to coordinate these and to plan ahead in accordance with the planning principles (see details in chapter 4 Site Development Plan).

The purpose and objective of introducing a technical plan with not only spatial rules.but also longer time limits and standardised principles vis-à-vis the BFO is precisely the precautionary management of the expansion of offshore wind energy. This is intended to ensure at the planning level that the offshore expansion is carried out in a physically well-organised and space-saving way in accordance with section 4 subsection 2 no. 2 WindSeeG and that environmental concerns are also assessed at the planning level.

9.2 Strategic alternatives

A strategic alternative, e.g. with regard to the goals of the Federal Government on which the planning is based, is currently not being considered for the Site Development Plan since the expansion goals of the Federal Government represent, as it were, the planning horizon for the Site Development Plan. The expansion targets arise from legal requirements (in particular the Renewable Energy Sources Act (EEG)). These are also an essential basis for the requirements planning of onshore grid expansion. Since a well-coordinated, synchronised approach to onshore and offshore grid and capacity expansion to reduce idle capacity or cut-offs would appear to make sense, the choice of an alternative expansion strategy is out of the question in this context.

Accordingly, it was assumed that the expansion target of 15 GW of installed capacity of offshore wind turbines in 2030 would be achieved. For informational purposes, other possible future expansion scenarios, some with a planning horizon extending beyond 2030, and their effects on the rules in the Site Development Plan were outlined in the Annex (see chap. 13 Site Development Plan).

9.3 Spatial alternatives

As far as assessment of spatial alternatives is concerned, the Site Development Plan defines both spatial and textual rules in the form of planning principles and standardised technical principles for areas and sites, submarine cable systems and platforms in the German North Sea EEZ. To a large extent, these requirements serve to ensure that uses are designed to be as eco-friendly as possible and that the different concerns and legal positions are balanced in a manner that is in line with the various interests. Taking into account the above-mentioned existing uses and rights of use, only a few feasible alternatives to these rules are apparent which, in an objectively plausible manner, can be expected to have significantly lower environmental effects. The spatial rules of the Site Development Plan fit in with the existing uses such as shipping traffic, military usage, marine research, etc. and the area designations defined for the North Sea EEZ within the framework of the Spatial Plan and BFO-N. This means that the planning of areas and sites, but also of platforms and routes, is limited from the outset. Areas, sites and platforms are specified according to the planning principles, taking into account nature conservation sites and legally protected biotopes, as well as economic area use and distance regulations.

The cable routes are planned to cover the shortest possible route in accordance with the planning principles, with a view to minimising environmental impact, as long as there are no overriding concerns to the contrary. The cable systems are also predominantly planned in parallel with infrastructures (pipelines, cables, wind farms) applied for/approved/constructed so as not to slice up any additional spaces.

The spatial location of the gates results from the regional planning rules and other planning considerations in the coastal states adjoining the plans of the EEZ. In turn, the plans of the coastal states are based on the routing to suitable high-voltage and ultra-high-voltage grid connection points on land. Secondly, routing perpendicular or parallel to existing pipelines is selected in order to cross the traffic separation areas. As anchor prohibition zones have already been established next to the pipelines, few additional impairments for shipping traffic are to be expected here. Under these conditions, there are no spatial alternatives to the selected gates to coastal waters as there is no further room for manoeuvre in the area between the traffic separation areas due to wind farms and pipelines that have already been consolidated or approved under planning law. The following applies to the individual gates: gates N-I (Ems), N-II (Norderney) and N-IV (Büsum) have been adopted from the Spatial Plan or the regional plans of the coastal states and are coordinated accordingly. For gate N-III (Europipe 2), the state of Lower Saxony has issued a state planning specification for the interconnector "NorGer".

9.3.1 Examination of alternatives for areas

With regard to the examination of alternatives for areas, reference is made to the information in the Site Development Plan on the definition of the individual areas (chap. 5.1). There are no serious alternatives to areas N-1 to N-13 due to the rules of the applicable Spatial Plan for the EEZ of the North Sea or conflicts with other uses such as nature conservation areas or military training areas. Areas to the north-west of the spatially defined shipping route 10 are not seriously alternatives to the areas designated in the Site Development Plan. The defined areas N-1 to N-13 (areas N-4 and N-5 will be assessed for possible subsequent use) in the North Sea represent firstly a coherent planning area and secondly the areas north-west of shipping route 10 are significantly farther from the coast. This results in a significant extension of the necessary connection systems and thus a major intervention in the seabed in every case. In addition, the available data and information basis for the area north-west of shipping route 10 is much worse than for the area designated in the Site Development Plan due to the lack of project-related monitoring data.

Also in the EEZ of the Baltic Sea, no reasonable alternatives to areas O-1 to O-3 are discernible due to the rules of the applicable Spatial Plan for the EEZ of the Baltic Sea. In the coastal waters of Mecklenburg-Western Pomerania, areas O-4, O-5 (area currently under review) and O-6 and a test field are designated by an administrative agreement. For these areas, reference is made to the evaluations of the SEA on the Mecklenburg-Western Pomerania regional development programme.

9.3.2 Comparison of the sites with one another

Within the scope of the Site Development Plan (chap. 5.2.2), the sites designated or assessed in the Site Development Plan are compared with one another from the perspective of the criteria for the decision concerning the stipulation of the areas, including conflicts with other uses. In addition to the information provided in the Site Development Plan, possible conflicts from a nature conservation perspective are examined in detail here.

The following criteria are used to compare sites using nature conservation criteria:

- distance to nearest protected area in km (broken down into FFH areas and bird sanctuaries)
- location inside/outside the main concentration area of divers
- location inside/outside of the main distribution area of the harbour porpoise
- impact on biotopes protected under section 30 of the Federal Nature Conservation Act and suspected areas on the site
- route of the connecting line through a nature conservation area (EEZ) in km
- route of the connecting line through section 30 biotope/section 30 suspected areas (EEZ) in km
- importance of the site to the individual factors (textual).

Table 12. Comparison of sites using nature conservation criteria

Site	**Minimum distance (km) to the closest protected area pursuant to the Habitats Directive | Wild Birds Directive**		**Site inside the main concentration area of divers**	**Site inside the main distribution area of the harbour porpoise**	**Impact on section 30 biotopes/suspected areas on the site**	**Connecting line through nature conservation area (proportion EEZ, km)**	**Connecting line through section 30 biotype/suspected areas (proportion of route EEZ, km)**
N-3.7	26	21	No	No	Unknown	No	No
N-3.8	20	22	No	No	Unknown	No	No
O-1.3	9	13	-	-	Suspected area	No	No
N-7.2	28	58	No	No	Unknown	No	Yes, 2 km suspected area
N-3.5	14	18	No	No	Unknown	No	No
N-3.6	11	21	No	No	Unknown	No	No
N-6.6	27	6	No	No	Unknown	No	Yes, approx. 10 km (chap. 9.3.4)
N-6.7	40	33	No	No	Unknown	No	Yes, approx. 10 km (chap. 9.3.4)
N-9.1 TF	48	30	No	No	Unknown	No	Yes, approx. 10 km (chap. 9.3.4)
O-2.2 (under assessment)	12	23	-	-	Unknown	No	No
N-5.4 (under assessment in the drafts)	5	17	Yes	Yes	Yes	Yes, approx. 157 km (chap. 9.3.3)	Yes, approx. 3 km sandbank + 13 km suspected area (chap. 9.3.3)

Specifically:

North Sea

The designated sites N-3.7, N-3.8, N-3.5 and N-3.6 in area N-3 are more than 10 km from the nearest nature conservation area "Borkum Reef Ground". The closest distance to the main concentration area of divers is about 40 km, while the main distribution area of harbour porpoises is at least 34 km away from the individual sites. According to the current state of knowledge, the sites are considered to be of medium importance for resting birds and birds searching for food (see chap. 2.9.3.1). For harbour porpoises, the importance of the sites in area N-3 is currently assumed to be medium to high – seasonally in spring. For areas N-1 to N-3, monitoring results show a significantly higher occurrence in the "Borkum Reef Ground" nature conservation area with decreasing densities in an easterly direction (chap. 2.8.3.1). No occurrence of protected biotopes is known in the designated sites N-3.5, N-3.6, N-3.7 and N-3.8. Due to the small overlap of area N-3 with the "Borkum Reef Ground" sandbank and the otherwise predominantly homogeneous, fine to medium sandy sediment conditions, area N-3 is considered to be of minor importance with regard to the protected asset Biotopes in the southwestern subarea.

The connecting lines for all four sites run in the EEZ outside nature reserves and outside known occurrences of legally protected biotopes. According to the current state of knowledge, no significant nature conservation conflicts can therefore be identified for the sites designated in area N-3.

Site N-7.2 is located at a considerable distance from nature conservation areas (min. 28 km). The main concentration area of divers and the main distribution area of harbour porpoises are both more than 50 km away from N-7.2. According to the current state of knowledge, area N-7 is assigned medium importance for harbour porpoises (see chapter 2.8.3.1) and seabirds and resting birds (chap. 2.9.3.1). This area is most frequently used by deep-sea bird species, which occur widely throughout the North Sea. Species such as divers that are susceptible to disturbance are only present in the areas for a short period as they search for food, and during the main migration periods. The benthic community in the location of the designated site N-7.2 is assigned average to above-average importance due to the occurrence of burrowing megafauna species (chapter 2.6.3.1). According to the current state of knowledge, the occurrence of legally protected biotopes in site N-7.2 is not to be expected (chap. 2.5.3.1). The connecting line for site N-7.2 in the EEZ runs outside nature conservation areas, but the cable crosses suspected areas of "species-rich gravel, coarse sand and shell layers" over a distance of around 2 km. Based on the current state of knowledge, any potential small-scale conflicts can therefore be identified with regard to the route of the connecting line.

Sites N-6.6 and N-6.7 are also located far away from nature conservation areas (min. 25 km) and at a considerable distance from the main concentration area of divers and the main distribution area of harbour porpoises (each more than 55 km). The sites are assigned medium importance for harbour porpoises as well as for seabirds and resting birds. Due to the occurrence and ecological significance of the burrowing soil megafauna, the benthic biocoenosis is considered to be of average to above-average importance in the area of the designated sites of area N-6 (chap. 2.6.3.1). According to the current state of knowledge, the designated sites N-6.6 and N-6.7 are not expected to contain legally protected biotopes (chap. 2.5.3.1). The connecting lines for both sites in area N-6 in the EEZ run completely outside of nature conservation areas; the routes cross the protected sandbank biotope type over a distance of around 10 km. Thus, according to the current state of knowledge, potential conflicts would be conceivable in terms of the route of the connecting line, but less so in terms of the sites themselves. Refer to the examination of alternatives of the cable routes to bypass the sandbank in chap. 9.3.4.

Sub-site N-9.1 is about 30 km away from the nearest protected area. The distance to the main distribution area of harbour porpoises is 58 km, while the distance to the main concentration area of divers is as far as 63 km. The overall site is of medium importance for the protected areas of marine mammals and of sea birds and resting birds. For the factor Benthos, the siteis assigned an average to above-average importance due to the occurrence of species of the burrowing soil megafauna in the N-9.1 area. The possibility of the occurrence of legally protected biotopes in the site can be excluded based on the current state of knowledge. In spite of the occurrence of sediments with partly high silt content and species of the burrowing soil megafauna (chap. 2.6.3.1), the legally protected biotope type "silt bottom with burrowing soil megafauna" can be excluded due to the lack of sea feathers. The connecting line for site N-9.1 runs for almost 10 km through the protected biotope type "sandbank", but in the EEZ completely outside of protected areas. Thus, according to the current state of knowledge, potential conflicts could arise with regard to the route of the connecting line (see also the examination of alternatives to bypassing the sandbank in chap. 9.3.4).

Site N-5.4, which is described in the (preliminary) drafts of the Site Development Plan, is at a minimum distance of 5 km from the "Sylt Outer Reef – Eastern German Bight" nature conservation area. The distance to the nearest bird sanctuary "Eastern German Bight" is about 17 km. The site lies both in the main concentration area of divers and in the main distribution area of harbour porpoises. Due to the sometimes extensive occurrence of the biotopes "sublittoral sandbank", "reefs" and "species-rich gravel, coarse sand and shell layers", site N-5.4, which is described in the preliminary drafts of the Site Development Plan, is of high importance with regard to the factor Biotope types. In view of the relatively high diversity of species and the high structural heterogeneity, the benthic community can be regarded as above average in terms of the overall site. According to the current state of knowledge, the environment of site N-5.4, which is described in the (preliminary) drafts of the Site Development Plan and is currently under assessment, is of high importance for harbour porpoises and represents the core area of the identified main distribution area of harbour porpoises in the German North Sea (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2013; see chapter 2.8.3.1). For the factor Seabirds and resting birds, the very high importance of the surroundings of the entire area N-5 for the red-throated and black-throated divers listed in Annex I of the V Directive must be emphasised (chap. 2.9.3.1).

Research and monitoring results consistently show that the avoidance behaviour of divers in relation to offshore wind farms and the associated habitat loss is much more pronounced than originally assumed. Current results from the wind farm projects in area N-5 show significant average avoidance distances of approx. 15 km in the western part of the area (see chapter 5.2.2.1). In accordance with the precautionary principle and in order to exclude the possibility of a threat to the marine environment as defined in section 5 subsection 3 WindSeeG and a significant disturbance as defined in section 44 subsection 1 no. 2 of the Federal Nature Conservation Act with the necessary certainty, the Site Development Plan does not designate site N-5.4 as described in the (preliminary) drafts of the Site Development Plan (see chap 7.4 and 7.5 of the Site Development Plan).

The connecting line for site N-5.4, which is described in the (preliminary) drafts of the Site Development Plan, runs in the EEZ over a distance of 157 km, and thus almost completely, through the "Sylt Outer Reef – Eastern German Bight" nature conservation area. The route crosses known occurrences of the FFH habitat "sandbank" over a distance of about 3 km and suspected areas of the section 30 biotope "species-rich gravel, coarse sand and shell layers" over a distance of about 13 km. The procedure for the parallel SylWin1 connection system showed that bypassing these occurrences of gravel, coarse sand and shell layers was problematic. From a nature conservation perspective, this gives rise to considerable conflicts with regard to site N-5.4, which is the area under assessment in the (preliminary) drafts of the Site Development Plan.

For migratory birds, the individual marine areas in sites N-1 to N-13 are of average to above-average importance. The current state of knowledge does not reveal any significant differences between the individual areas and areas. Also it is not currently possible to draw a definitive conclusion on a possible decreasing migration intensity with increasing distance from the coast. This means that the factor Migratory birds is no longer taken into account in the comparison of the sites in the North Sea that have been designated and assessed. The same applies to the factor Fish, for which the available catch data and methods can only provide a general description of the importance of sites and areas. The overview of the species records by area did not show any particular significance of a specific area for the constant, frequent character species.

The results show that site N-9.1 represents a reasonable alternative to site N-5.4, which was assessed in the (preliminary) drafts of the Site Development Plan, at least in terms of the nature conservation concerns examined here.

Baltic Sea

Site O-1.3 in the Baltic Sea is just 10 km away from the nearest protected area "Pomeranian Bight – Rönnebank". According to the current state of knowledge, the benthic biocoenosis in site O-1.3 is of medium importance overall (chap. 2.6.3.1 Baltic Sea Environmental Report). In the north/eastern part of site O-1.3, a residual sediment area with coarser sediments and occurrence of overgrown rocks was found. The area occurring here is a suspected area of the legally protected biotope type "reefs" (chap. 2.5.4.1 Baltic Sea Environmental Report). This residual sediment area with scattered stones overgrown with macrozoobenthos is to be considered as a reef suspected area of higher value. For harbour porpoises, site O-1.3 is of medium to seasonal importance in the winter months. The significance results from the possible use by individuals of the separate and highly endangered Baltic Sea population of the harbour porpoise. However, the area is used irregularly by harbour porpoises as a transit area, as a stopover and as a feeding ground (chap. 2.8.3.1 Baltic Sea Environmental Report). For seabirds, all previous findings indicate an average importance of the site O-1.3. Area O-1, in which the site is located, has an average occurrence of seabirds overall and also only an average occurrence of endangered species and species requiring strict protection (chap. 2.9.3.1 Baltic Sea Environmental Report). With regard to the factor Migratory birds, site O-1.3 is of average importance for migrating water birds, and of average to above-average importance for birds that migrate at night. A differentiated analysis is necessary for crane migration. Well-known main routes are undoubtedly of above-average importance. The adjacent areas of these main migration routes, e.g. area O-1.3, are likely to be of average to above-average importance depending on wind force and direction. Cranes may drift from the main migration route to site O-1 in strong westerly winds (chap. 2.10.3.3 Baltic Sea Environmental

Report). The route for the connection of site O-1.3 in the EEZ runs outside of protected areas and outside of known occurrences of protected biotopes. There are indications of possible conflicts with bird migration or biotope protection on site O-1.3. These indications will be examined as part of the subsequent preliminary investigation to close existing gaps in knowledge. The results of the preliminary investigation will also be taken into account in the spatial development planning.

The site under assessment O-2.2 is at a distance of 12 km from the nearest nature conservation area. The route for the connection of the site in the EEZ also runs outside of nature conservation areas and outside of known occurrences of protected biotopes. Site O-2.2 shows low structural abundance overall. The occurrence of legally protected biotopes is not to be expected in this area (chap. 2.5.4.1 Baltic Sea Environmental Report). The area has little significance for the Benthos. The predominant benthic species consists mainly of species that regenerate rapidly (chap. 2.6.3.1 Baltic Sea Environmental Report). According to the current state of knowledge, the area is used by harbour porpoises as a transit area. Based on the current knowledge, a medium to high seasonal importance of site O-2 for harbour porpoises can be inferred. The seasonally high importance of the area results from the possible use by individuals of the separate and highly endangered Baltic Sea population of the harbour porpoise in the winter months (chap. 2.8.3.1 Baltic Sea Environmental Report). All previous findings indicate that site O-2 is of little importance for seabirds. The area has a low occurrence of endangered species and species requiring special protection (chap. 2.9.3.1 Baltic Sea Environmental Report). Overall, the part of site O-2.2 under assessment for migratory water birds is of average to above-average importance. In particular, the baseline survey of the area south of O-2.2 identified a high number of individual common scoters. In 2011, 8,174 birds were counted. Thus approx. 1.5 % of the biogeographical population moved through site O-2. The area is thus of above-average importance for common scoter migration. The largest part of nocturnal bird migration takes place in a broad front over the Baltic Sea. Due to the very high numbers of individuals to be expected and the significant proportion of endangered species, site O-2.2 is of average to above-average importance for the night migration.

A differentiated analysis is necessary for crane migration. In the area of O-2, a total of 1,231 migrating cranes were recorded during the 2008 autumn migration, which corresponds to about 3.1% of the Pomeranian resting population or 1.37 % of the biogeographical population. Most of these birds probably drifted here from a flight route South Sweden-Rügen to the southeast by north-westerly winds. Site O-2.2 is located close to known main migration routes and is therefore probably of average to above-average importance for bird migration, depending on the wind force and direction (chap. 2.10.3.3 Baltic Sea Environmental Report). Thus, nature conservation conflicts are evident at site O-2.2 with regard to the factor Migratory birds, especially from a cumulative point of view.

9.3.3 Alternative routes for gates N-IV and N-V

Alternative routes to Lower Saxony for gate N-II (Norderney) were assessed for the NOR-7-2 system, in addition to the route proposed in the plan for gate N-IV/N-V. These are solely spatial variants as they do not represent an alternative in temporal terms. Please see the alternative assessment of NOR-3-2 and NOR-6-3 for NOR-7-2 in the Site Development Plan in chapter 5.5.2.

In BFO-N 2016/2017, instead of NOR-7-2, connecting line NOR-5-2 led to gate N-V. For this reason, an alternative is considered here from NOR-7-2 to gate N-V and NOR-5-2 to gate N-IV (see Figure 35). Please note that the definition of area N-5 for any subsequent use is under assessment and site N-5.4 is not defined in the Site Development Plan (see chapter 5.2.2. Site Development Plan).

A comparison of the NOR-7-2 and NOR-5-2 routes to gates N-V and N-IV shows that the number of intersections required with existing or planned cables or lines for the NOR-7-2 route is much higher. However, it also appears that the route from NOR-5-2 to gate N-IV, at a distance of 159 km, would be almost 70% longer than the NOR-7-2 route (94 km). Moreover, NOR-5-2 would run almost entirely (157 km) within the nature conservation area and, in places, within or in the immediate vicinity of known section 30 biotope occurrences. Overall, therefore, the proposed NOR-7-2 alternative is expected to have less impact on the marine environment than the route of NOR-5-2.

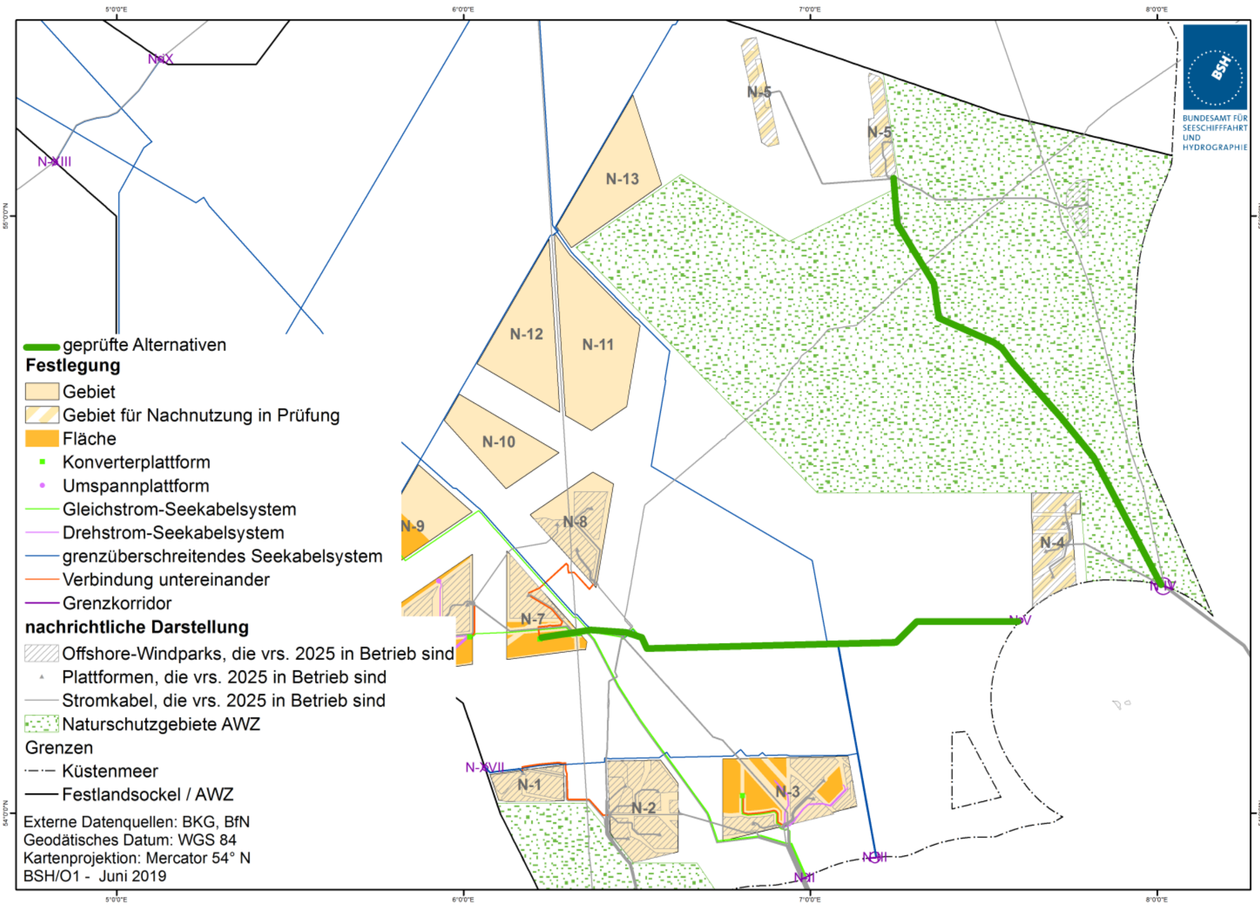


Figure 35: Alternative routes for gates N-IV and N-V.

9.3.4 Bypass sandbank Borkum reef ground

An alternative assessment is carried out for all cable systems running to boundary corridor N-II with regard to the routing of cables via the Borkum Reef Ground sandbank, compared with bypassing the sandbank. This concerns the cable routes of the NOR-6-3 and NOR-9-1 connecting lines (in the future, also NOR-9-2 and NOR-10-1). As only sites located west of gate N-II are connected via the said cable routes, a route running west of area N-2 via the sandbank is significantly shorter overall than a route running east of area N-2 (see

Table 13).

In the western route variant, the Borkum Reef Ground sandbank is crossed (see Figure 36:) – depending on the cable in question – over an average length of 10 km. However, the FFH habitat type "sandbank" is crossed outside of the protected area at the eastern spurs of the sandbank and outside of known occurrences of the FFH habitat type "reef" or outside of known occurrences of the section 30 biotope type "Species-rich gravel, coarse sand and shell layers" within the sandbank. The routes in the Site Development Plan west of area N-2 will be specified due to the significant additional length totalling 75 km when bypassing the sandbank, and four additional crossings required for the NOR-6-3 connection.

Table 13: Comparison of the route distances for the variants via the sandbank v bypassing the Borkum Reef Ground sandbank

	Variant via the sandbank	Variant bypassing the sandbank	Difference
Route length, EEZ	NOR-6-3: 91 km NOR-9-1: 118 km	NOR-6-3: 128 km NOR-9-1: 156 km	NOR-6-3: 37 km NOR-9-1: 38 km
Number of EEZ intersections with existing or planned lines			NOR-6-3: 4 NOR-9-1: 0
Involvement of section 30 biotopes (if known)	Yes Sandbank NOR-6-3: 10.4 km NOR-9-1: 9.6 km	no	

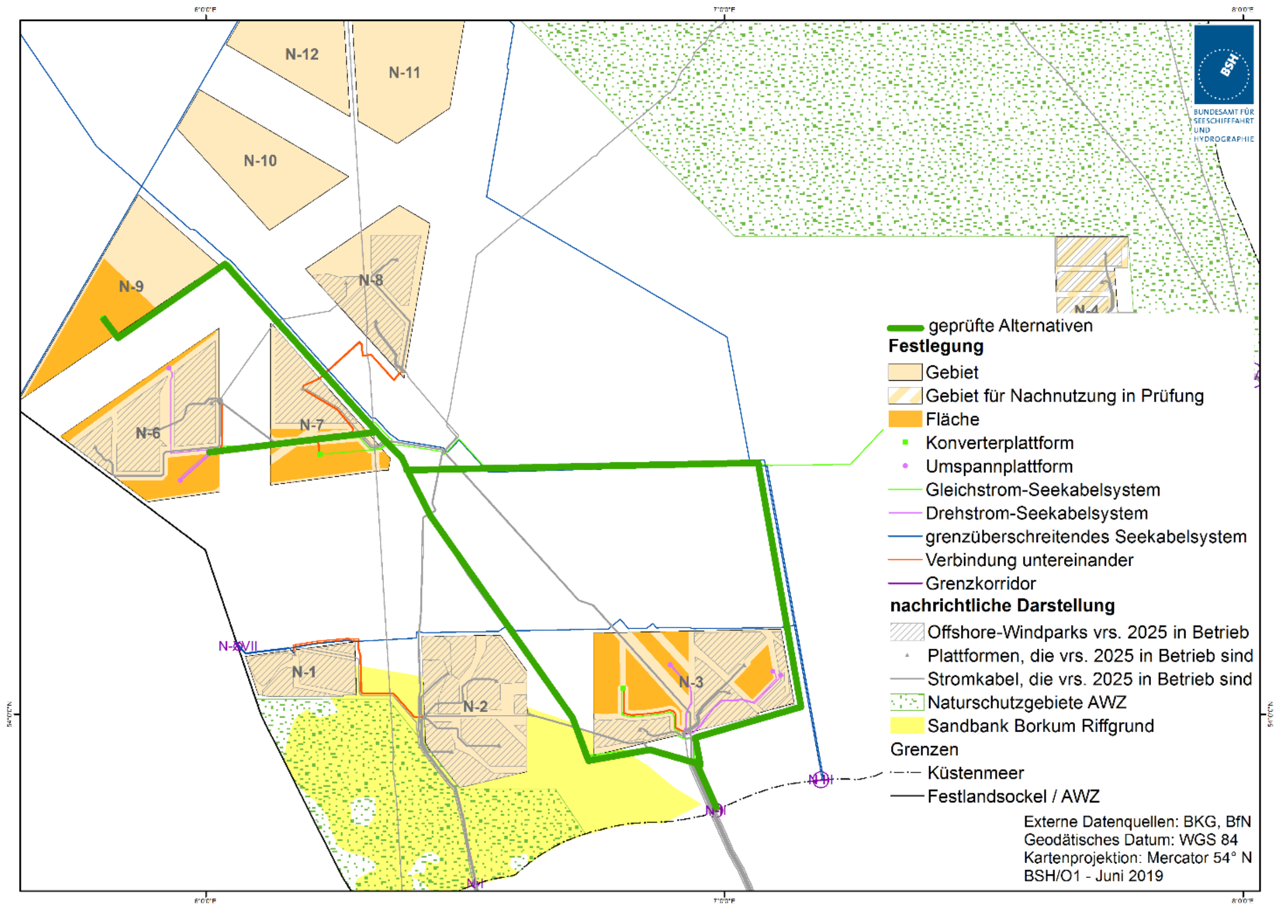


Figure 36: Alternative routes for the connection of sites N-6.3 and N-9.1.

9.3.5 Other alternatives assessed

As well as the stated alternative assessments, other alternatives were assessed when preparing the Site Development Plan. For example, a small-scale alternative for the converter location in area N-6 was assessed. The size of the site to be developed is decisive for the choice of the platform location. The chosen variant is preferable both from an economic standpoint and as regards marine spatial planning, as the available space can be used as efficiently as possible. From an environmental standpoint, there are no differences in the evaluation of the two variants on the basis of the available data. However, the economically motivated goal of use of the site that is as efficient as possible must also be clearly supported from a nature conservation standpoint.

A similar small-scale alternative assessment was carried out in area N-3 for the connecting line to the converter platform. Here, the variant defined in the Site Development Plan was also selected with a view to developing the available space as efficiently as possible. The above statements apply accordingly here.

9.4 Technical alternatives

The standard concept for the connection in the North Sea is a direct current system similar to the BFO-N. The transmission voltage is 320 kV for connection systems in zones 1 and 2 ± and 525 kV for zone 3 ±. An exception is the NOR-9-1 and NOR-9-2 connection systems, which are located in zone 3 but are connected with the transmission voltage ± 320 kV. The standard transmission output of 900 MW of the BFO-N is continued in the Site Development Plan for the connection systems with ± 320 kV in zones 1 and 2. Systems NOR-9-1 and NOR-9-2 are designed with a transmission capacity of 1,000 MW. Connection systems with a voltage of ± 525 kV have a standard transmission capacity of 2,000 MW. In individual cases (e.g. in area N-10), this standard transmission capacity may vary due to individual area availability. The length of the route for connecting a site or area to the grid connection point on land essentially appears to be the decisive factor for the selection of suitable transmission technology for grid connection of offshore wind farms. In the case of route lengths of more than 100 km, reactive power compensation devices are to be provided regularly for three-phase connections. Transmission losses also increase with the length of the cable system. These are significantly lower in the case of the HVDC. Route lengths of more than 100 km are to be expected in the future for the North Sea EEZ, and also significantly greater than that with increasing distance from the coast. When using the HVDC, multiple offshore wind farms or sites can essentially be connected due to the relatively high system performance of the collective connection, in which an HVDC grid connection system is used that consists of a converter platform and DC Subsea Cable. This means that a significantly smaller number of cable systems is required compared to a connection using three-phase current technology, thereby reducing the space required for the cable systems. Accordingly, the use of three-phase AC technology as transmission technology in the North Sea EEZ is out of the question. In the case of DC submarine cable systems with an increased transmission voltage of ± 525 kV, a bipolar version with metallic return conductor could be conceivable. In this case, a third cable – known as the metallic return conductor – would have to be included in the bundle in addition to the two standard DC submarine cables. In the event of failure of one pole, this type of design at least allows continued operation with the remaining pole, which appears to be expedient in terms of system stability with an increased transmission capacity of 2,000 MW. To what extent the interpretation is actually based on this concept is not yet known or is not specified in the Site Development Plan. A corresponding assessment would therefore be the subject of an update of the Site Development Plan or, if applicable, of the respective individual approval procedure.

For the connection of offshore wind farms or the connection of a transformer platform of the offshore wind farm to the converter platforms, the BFO-N has so far envisaged the 155 kV connection concept, which can be considered as a technical alternative to the standard 66 kV connection concept planned in the Site Development Plan as a direct connection of the offshore wind turbines to the converter platform in certain cases – for example in the case of sites located far apart. However, in order to reduce the number of submarine cables required for this alternative, an increase in the transmission voltage to 220 kV is defined.

The rule of the direct connection of wind turbines to the converter platform as a standard concept also leads to savings in terms of space required. This is due to the fact that transformer platforms are no longer necessary and may be omitted, but a separate platform may be required for maintenance and accommodation purposes for offshore wind farms. There could also be savings in terms of submarine cables, depending on the spatial location of the future converter platform.

The increase of the standard transmission voltage of the high-voltage direct current transmission systems to ± 525 kV was discussed as part of the preparation procedure in the Site

Development Plan. Based on currently available information, the availability of the technology (particularly submarine cables) in 2030 can be considered realistic. According to the transmission grid operators, the space required and thus the size of the converter platform increases for the transmission of 2,000 MW; however, no additional converter platform is required. The significant increase in the transmission capacity from 900 MW to 2,000 MW results in a significant reduction in the required route corridors. Against the background of the strict spatial restrictions when routing onshore connecting lines, an increase in the standard transmission capacity would therefore appear to make sense.

The idea of a direct current grid is not yet technically viable. Here, power inversion in the offshore wind turbines will be dispensed with and a purely direct current grid will be built offshore. With the aid of DC-DC converters, the low DC voltage of wind turbines e.g. on a platform for transport on land is increased to maximum voltage (e.g. ± 320 kV or ± 525 kV).

As a further concept, the insular construction of several platforms for connecting the wind farms in the immediate vicinity to regions further away from the coast should be assessed. This option, too, has not yet reached a stage that warrants an in-depth assessment. Therefore, this possibility is obviously still a long way off at present.

With regard to an alternative use of the areas and sites, generation of hydrogen by means of electrolysis was introduced within the framework of the consultation as an alternative to the grid-bound transport and use of the electricity generated. A more detailed analysis is planned within the framework of the Site Development Plan update.

10 Measures envisaged for monitoring the environmental impacts

The potential significant effects on the environment resulting from the implementation of the plan are to be monitored in accordance with section 45 UVPG. The aim is to identify unforeseen adverse effects at an early stage and take appropriate remedial action.

Accordingly, in accordance with section 40 subsection 2 no. 9 UVPG, the environmental report is to specify the measures envisaged for monitoring the significant environmental effects of implementation of the plan. Monitoring is the responsibility of the Federal Maritime and Hydrographic Agency as it is the authority responsible for the SEA (see section 45 subsection 2 UVPG). As intended by Art. 10 subsection 2 of the SEA Directive and section 45 subsection 5 UVPG, existing monitoring mechanisms can be used to avoid duplicating monitoring work. Pursuant to section 45 subsection 4 UVPG, the results of monitoring are to be taken into account in the update of the spatial development plan.

With regard to the planned monitoring activities, it should be noted that the actual monitoring of the potential effects on the marine environment can only begin when the Site Development Plan is implemented, i.e. when the decisions made within the framework of the plan are implemented. Nevertheless, the natural development of the marine environment, including climate change, should not be disregarded when assessing the results of monitoring activities. However, general research cannot be carried out within the framework of monitoring. Therefore, project-related monitoring of the effects of the uses regulated in the plan is of particular importance.

The main function of plan monitoring is to bring together and evaluate the results of different phases of monitoring at the level of individual projects or clusters of projects developed in a spatial and temporal context. The assessment will also cover the unforeseen significant effects of the implementation of the plan, the marine environment and the review of the forecasts in the environmental report. In this context, in accordance with section 45 subsection 3 UVPG, the Federal Maritime and Hydrographic Agency will ask the competent authorities for the monitoring results available there; these are required for implementation of the monitoring activities.

Results from existing national and international monitoring programmes must also be taken into account, also with a view to preventing duplication of work. The monitoring of the conservation status of certain species and habitats required under Art. 11 of the Habitats Directive must also be included, as must the investigations to be carried out in the context of the management plans for the nature conservation areas "Sylt Outer Reef – Eastern German Bight" and "Borkum Reef Ground". It will also provide links with the measures provided in the Marine Strategy Framework Directive and the Water Framework Directive.

In summary, the planned measures for monitoring the potential effects of the plan can be summarised as follows:

- Consolidation of data and information for the description and evaluation of the status of areas, factors and possible effects from the development of individual projects,
- Development of suitable procedures and criteria for evaluation of the results from effect monitoring of individual projects,
- Development of procedures and criteria for evaluation of cumulative effects,
- Development of procedures and criteria for forecasting possible effects of the plan in a spatial and temporal context,

- Development of procedures and criteria for evaluating the plan and adapting or, where appropriate, optimising it as part of the update,
- Evaluation of measures to prevent and mitigate significant effects on the marine environment,
- Development of norms and standards.

The following data and information are required in order to assess the possible effects of the plan:

1. Data and information available to the Federal Maritime and Hydrographic Agency within the scope of its responsibility:
    - Data resources from previous EIS and monitoring of offshore projects that are available to the Federal Maritime and Hydrographic Agency for review (according to the Offshore Installations Ordinance),
    - Data resources from the right of subrogation (according to WindSeeG),
    - Data resources from the site investigations (according to WindSeeG),
    - Data resources from the construction and operation monitoring of offshore wind farms and other uses
    - Data from national monitoring, collected by or on behalf of the Federal Maritime and Hydrographic Agency,
    - Data from Federal Maritime and Hydrographic Agency research projects.
2. Data and information from the areas of responsibility of other Federal and State authorities (on request):
    - Data from national monitoring of the North Sea and the Baltic Sea (formerly BLMP),
    - Data from monitoring activities as part of the implementation of the Marine Strategy Framework Directive,
    - Data from the monitoring of Natura 2000 sites,
    - Data provided by States from monitoring activities in coastal waters,
    - Data from other authorities responsible for authorising uses at sea 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, e.g.:
    - HELBIRD / DIVER,
    - Sediment EEZ.
4. Data and information from evaluations carried out within the scope of international committees and conventions:
    - OSPAR
    - ASCOBANS
    - AEWA
    - BirdLife International.

For reasons of practicability and appropriate implementation of requirements from the strategic environmental assessment, the Federal Maritime and Hydrographic Agency will pursue an approach focusing on the interdisciplinary compilation of information on the marine environment that is as ecosystem-oriented as possible when monitoring the possible effects of the plan. To be able to assess the causes of planned changes in parts or individual elements of an ecosystem, the anthropogenic variables from spatial observation (e.g. technical information on shipping traffic from AIS data resources) must also be considered and included in the assessment.

When combining and evaluating the results from monitoring at project level and from other national and international monitoring programmes, and from the accompanying research, it will be necessary to review the gaps in knowledge and uncertain forecasts presented in the environmental report. This applies in particular to forecasts concerning assessment of significant effects on the marine environment from the uses regulated in the Site Development Plan. The cumulative effects of defined uses are to be assessed regionally and supraregionally.

10.1 Monitoring of the potential effects of the areas and sites for offshore wind turbines

The investigation of the potential environmental effects of areas and sites for offshore wind energy is to be carried out at the secondary project level, based on the standard "Investigation of impacts of offshore wind turbines (StUK4)" and in coordination with the Federal Maritime and Hydrographic Agency. The results from the investigations for the sites of the future offshore wind farm projects are to be used as a basis for assessment of the locations with regard to the biological factors. Monitoring during construction of foundations by means of pile-driving work involves measuring underwater noise and acoustic recordings of the effects of pile-driving noise on marine mammals using POD measuring instruments. Additional monitoring measures are also planned in order to assess the effects of the stratification of the water under certain hydrographic conditions on the propagation of pile-driving noise in the Baltic Sea, and to allow further measures to be implemented if necessary. These measures may include additional noise measurements coupled with CTD measurements at different water depths in order to detect possible changes in noise propagation attenuation due to stratification of the water body.

Investigations are required for all factors in accordance with the requirements of StUK4 for the entire duration of the construction phase and for a period of between three and five years. Continuation of the operational monitoring beyond the period, as specified in the Standard "Investigation into the impacts of offshore wind turbines" (StUK 4), may be technically necessary with regard to project-related or area-specific conditions to an appropriate extent. The decision on the necessity and scope of continued operational monitoring is expressly reserved by Federal Maritime and Hydrographic Agency as the enforcement and monitoring authority. The Federal Maritime and Hydrographic Agency implements many projects as part of its accompanying research into the possible impacts of offshore wind turbines on the marine environment.

The Federal Maritime and Hydrographic Agency's research projects directly related to the possible effects on factors and the development of norms and standards include the following:

- Project ANKER "Approaches to cost reduction in the surveying of monitoring data for offshore wind farms", FKZ 0325921, with funding from the Federal Ministry for Economic Affairs and Energy/PtJ,
- R&D study BeMo "Evaluation approaches for underwater noise monitoring in connection with offshore licensing procedures, spatial planning and the Marine Strategy Framework Directive", with funding from the Federal Ministry of Transport and Digital Infrastructure/Federal Maritime and Hydrographic Agency,
- R&D project "Sound mapping", with funding from the Federal Ministry of Transport and Digital Infrastructure/Federal Maritime and Hydrographic Agency,
- R&D cooperation, NavES "Eco-friendly offshore developments", with funding from the departmental research plan of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety; several sub-projects belong to NavES:

- MultiBird, investigation of the collision risk of migratory birds,
- ProBird, forecast of migratory bird activity,
- ERa, field report on pile-driving noise,
- Noise I and II. development of technical information systems for underwater noise,
- Noise I and II, evaluation of underwater noise measurements.

The measures implemented to date include development of measurement regulations for measuring underwater noise (2011), development of measurement regulations for determining the effectiveness of noise mitigation systems (2013), and cooperation on the development of ISO 18406:17 and DIN SPEC 45653.

The results from ongoing Federal Maritime and Hydrographic Agency projects will be directly incorporated into the further development of standards, such as the development of StUK5.

10.2 Monitoring of potential effects of platforms

The same monitoring measures as stated in 0 are to be applied to the platforms provided for in the Site Development Plan.

10.3 Monitoring of the potential effects of submarine cables

The potential effects of submarine cable systems on the marine environment can only be assessed in specific projects. For the first time, StUK4 also includes minimum requirements for investigation of submarine cable routes with regard to benthos, biotope structure and biotopes during the baseline survey and the operating phase of the submarine cable systems. Thus, during the baseline survey, each biotope structure identified by sediment surveys along the cable route must be documented with at least three transverse transects for the benthic surveys. Additional transverse transects must also be defined at the start and end points of the route. In turn, each transverse transect consists of five stations. Identified suspected sites of biotopes that are protected in accordance with section 30 of the Federal Nature Conservation Act must also be examined in terms of spatial delimitation in accordance with the current mapping instructions from the Federal Agency for Nature Conservation.

After the cable system has been laid, its position must be indicated annually to the licensing authority during the first five years of operation, in accordance with current licensing practice, by implementing at least one survey of the depth of the system. The number of surveys in subsequent years is determined by the licensing authority on a case-by-case basis. Investigations with regard to the marine environment are to be carried out in coordination with the licensing authority on a project-specific basis. The investigation methods are to be presented, as far as possible, as described in the "Standard – Investigation of the impacts of offshore wind turbines on the marine environment (StUK4)". Investigations of the benthic communities on the same transects as in the baseline survey are to be carried out one year after commissioning of the submarine cable systems in order to examine possible effects from the construction and operation phases.

In addition, measures are planned to monitor implementation of the plan, which will help to verify and, if necessary, to evaluate forecasts of the significant impacts of offshore wind energy. Adapting use strategies and planned avoidance and mitigation measures or reviewing assessment criteria, especially with regard to cumulative impacts.

The strategic environmental assessment for the plan will use new findings from the environmental impact studies and from the joint evaluation of research and EIA data. Through a joint analysis of the research and EIA data, products will also be developed that provide a better overview of the distribution of biological factors in the EEZ. Consolidation of information is leading to an increasingly solid basis for impact forecasting.

In general, the intention is to ensure that data from research, projects and monitoring is consistent and make this available for competent evaluation. In particular, attempts should be made to create common overview products in order to review the effects of the plan. The existing geodata infrastructure at the Federal Maritime and Hydrographic Agency, which includes data from physics, chemistry, geology, biology and 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 project-related monitoring activities and accompanying research, it is specifically provided that data collected within the scope of accompanying ecological research will also be consolidated at the Federal Maritime and Hydrographic Agency and archived on a long-term basis. The Federal Maritime and Hydrographic Agency is already collecting and archiving the data on biological factors from the baseline surveys of offshore wind energy projects and the monitoring of construction and operating phases in the MARLIN (MarineLife Investigator), a specialist information network for environmental assessments.

11 Non-technical summary

Subject and reason

According to sections 4ff. Offshore Wind Energy Act (WindSeeG), the Federal Maritime and Hydrographic Agency is compiling a Site Development Plan in agreement with the Federal Network Agency and in coordination with the Federal Agency for Nature Conservation, the Directorate-General for Waterways and Shipping (GDWS) and the coastal states. The Site Development Plan will be established for the first time and must be announced by 30 June 2019 in accordance with section 6 subsection 8 WindSeeG. When the Site Development Plan was drawn up, anenvironmental assessment as defined by the Environmental Impact Assessment Act (UVPG), known as a Strategic Environmental Assessment (SEA), was carried out. The main content of the Strategic Environmental Assessment is this environmental report. This identifies, describes and assesses the likely significant environmental impact of the implementation of the Site Development Plan, as well as possible planning alternatives, taking into account the essential purposes of the plan.

The Site Development Plan has the character of a technical plan. As an important control instrument, the sectoral plan is designed to plan the use of offshore wind energy in a targeted and optimal manner by defining areas and sites as well as locations, route corridors and routes for grid connections and interconnectors.

The Site Development Plan contains rules for the expansion of offshore wind turbines and the necessary offshore connection lines for the period from 2026 to at least 2030 with the aim of

- achieving the expansion target in section 4 No. 2b of the Renewable Energy Act,
- expanding the power generation from offshore wind turbines in a spatially ordered and compact fashion, and
- ensuring an ordered and efficient utilisation and loading of the offshore connecting - cables, and planning, installation, commissioning and use of offshore connecting cables in parallel with the expansion of power generation from offshore wind turbines.

Within the framework of the central model, the Site Development Plan is the control instrument for orderly expansion of offshore wind energy in a staged planning process. The Site Development Plan SEA is associated with upstream and downstream environmental audits. The Site Development Plan is classified as a technical plan according to the higher-level marine spatial planning. In the next step, the sites defined in the Site Development Plan for offshore wind turbines undergo preliminary investigation. If a site is deemed suitable for the use of offshore wind energy, the site is put up for tender and the winning bidder can apply for approval (planning permission or planning approval) for the construction and operation of offshore wind turbines on the site. No preliminary investigation will be carried out for the specified platform locations and cable routes. With regard to the character of the Site Development Plan as a steering planning instrument, the depth of the assessment of likely significant environmental impacts is characterised by a greater scope of investigation and generally a lower depth of investigation. As with the MSP instrument, the focus of the assessment is on evaluating cumulative effects and examining alternatives.

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

Strategic Environmental Assessment methodology

This environmental report builds on the methodology of the SEA of the Spatial Offshore Grid Plan, which has already been used as a basis, and develops it further with a view to the additional rules defined in the Site Development Plan that go beyond the Spatial Offshore Grid Plan.

The methodology is based primarily on the rules of the plan that are to be assessed. Within the framework of this SEA, whether the rules are likely to have significant effects on the factors in question is identified, described and evaluated for the individual rules. The subject matter of the environmental report is compliant with the provisions of the Site Development Plan as set out in section 5 subsection 1 WindSeeG. However, it is not so much the actual time specifications that are significant here as the time sequence of the invitation to tender or the calendar years for commissioning, as this has no further environmental impacts with regard to the spatial specifications. Although some planning and technical principles serve to mitigate environmental effects, they can also lead to effects, making a review necessary.

The assessment of the likely significant environmental effects of the implementation of the Site Development Plan includes secondary, cumulative, synergistic, short-, medium- and long-term, permanent and temporary, positive and negative effects related to the factors. The assessment of possible impacts is based on a detailed description and assessment of the environmental status. The SEA was carried out for the following factors:

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

The description and evaluation of the expected significant environmental impacts is carried out separately for protected areas and sites, platforms and submarine cable systems. Furthermore, where necessary, a differentiation is made according to different technical designs. The description and assessment of the likely significant effects of the implementation of the Site Development Plan on the marine environment also refer to the factors described. All plan contents that may potentially have significant environmental effects are examined.

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

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

In the context of the impact forecast, specific framework parameters for areas and sites, for platform locations and for cable routes are used as a basis for evaluation. Although no wind farm layouts are defined in the Site Development Plan to determine the projected output to be installed, certain parameters are assumed in the SEA for the analysis of the factor. To illustrate the range of possible (realistic) developments, the assessment is essentially based on two scenarios. Scenario 1 assumes many small installations, while scenario 2 assumes a small number of large installations. Because of the resulting range covered, a description and evaluation of the current state of planning that are as comprehensive as possible in relation to the factors become possible.

Regarding the areas, a total of 13 areas is assumed in a worst-case scenario, regardless of the concrete rule in the plan and the probability of implementation. According to section 5 subsection 1 no. 5 of the Offshore Wind Energy Act, the expected generation capacity of offshore wind turbines must be specified in the Site Development Plan for the areas or specifically for the sites. To determine the projected capacity to be installed, one or more layouts for offshore wind farm planning are not taken as a basis, but certain parameters such as number of turbines, hub height, height of the lower rotor tip, rotor diameter, total height, diameter of foundation types and scour protection are assumed for a factor-based analysis in this SEA.

Certain parameters, such as the number of platforms or the length of the farm's internal cabling, are also taken as a basis when assessing the locations for platforms. The definition of routes and route corridors for submarine cable systems is based on certain widths of the cable trench and the number and area of intersections and converter platforms.

Benthos

The North Sea EEZ is not of outstanding importance with regard to the species inventory of benthic organisms. Moreover, the benthic communities identified have no special features as they are typical for the North Sea EEZ due to the predominant sediments. Studies of macro-zoobenthos within the framework of the approval procedures for offshore wind farms and from AWI projects from 1997 to 2014 have revealed typical communities in the German North Sea. The species inventory previously found and the number of Red List species indicate that the study area for benthic organisms is of average importance.

The deep foundation work for wind turbines and platforms will result in disturbances of the seabed, sediment turbulence and formation of turbidity plumes. The re-suspension of sediment and subsequent sedimentation may lead to impairment or damage to the benthos in the immediate vicinity of the foundations for the duration of the construction activities. Due to the predominant sediment composition, however, these impairments will be only small-scale and short-term. The concentration of the suspended material generally decreases very rapidly with distance. Local land sealing and the introduction of hard substrates in the immediate vicinity of the structures as a result of construction work may lead to changes in the species composition.

Due to the laying of the submarine cable systems, only small-scale and short-term disturbances of the benthos due to sediment turbulence and turbidity plumes in the area of the cable route can be expected. Possible effects on the benthos depend on the laying methods used. With comparatively unobtrusive laying using the injection method, only minor disturbances of the benthos in the vicinity of the cable route are to be expected. Local sediment shifts and turbidity plumes are to be expected while the submarine cable systems are being laid. The predominant sediment composition in the North Sea EEZ means that most of the released sediment will settle directly at the construction site or in its immediate vicinity.

Benthic habitats will be built over directly in the vicinity of rockfills required for cable crossings. The resulting loss of habitat is permanent, but small in scale. This will result in a non-native hard substrate that may cause small-scale changes to the species composition.

For operational reasons, warming of the top seabed sediment layer may occur directly above the cable system. With sufficient installation depth and taking into account the fact that the effects will occur on a small scale, no significant effects on benthic communities are expected on the basis of current knowledge. With the planning principle for sediment warming, the Site Development Plan specifies that the 2K criterion must be adhered to. According to the assessment by the Federal Agency for Nature Conservation, this precautionary value ensures, with sufficient probability, that significant negative effects of cable warming on the marine environment will be prevented.

As things stand at present, the planned converter platforms and submarine cable routes are not expected to have any significant effects on the factor Benthos if the 2K criterion is met. The ecological effects are small-scale and mostly short-term.

Biotopes

Converter platforms and submarine cables may possibly affect protected biotopes due to direct use of these biotopes, their covering by sedimentation of material released during construction or potential habitat changes.

Given the predominant sediment composition, impairments due to coverage are likely to be small-scale and temporary as the released sediment will settle quickly. Permanent habitat changes are limited to the immediate region of the foundations and cable intersections. Required cable crossings will be secured with rockfill, which is a permanent, non-native hard substrate. This will offer a new habitat for benthic organisms that thrive on a hard substrate and may lead to a change in the species composition. Significant effects on the factor Biotopes due to these small-scale habitat changes are not to be expected. Moreover, the risk of negative impact on the benthic sediment community due to species atypical for the area is low, as recruitment of the species is very likely to take place from the natural hard substrate habitats.

Permanent habitat changes are limited to the immediate area of the foundations and rockfills required for cable crossings and when laying cables on the seabed. These rockfills will permanently provide a hard, non-native substrate. This will offer a new habitat for benthic organisms and may lead to a change in the species composition. Significant effects on the factor Biotopes due to these small-scale regions are not to be expected. Moreover, the risk of negative impact on the benthic sediment community due to species atypical for the area is low, as recruitment of the species is very likely to take place from the natural hard substrate habitats.

Fish

There is a typical species composition for fish fauna in the region of the areas and sites, converter platforms and submarine cable routes. In all regions, the demersal fish community is dominated by flatfish, as is typical for the German Bight. According to current knowledge, the areas and sites are not a preferred habitat for any of the protected fish species. Consequently, fish stocks in the planning area are of no overriding ecological importance compared to adjacent marine areas. According to the current state of knowledge, the planned construction of wind farms and the associated converter platforms and submarine cable routes is not expected to significantly affect the factor Fish. The effects of the construction of wind farms, converter platforms and submarine cable systems on fish fauna are limited both spatially and temporally. Sediment turbulence and the formation of turbidity plumes during the construction phase for the foundations and converter platforms and the laying of the submarine cable systems may lead to small-scale and temporary impairments of fish fauna. The turbidity of the water is expected to decrease rapidly due to the prevailing sediment and flow conditions. Thus, according to the current state of knowledge, the impairments will remain small-scale and temporary. Overall, small-scale impairments can be assumed for adult fish. Moreover, the fish fauna is adapted to the natural sediment turbulence caused by storms that are typical here. During the construction phase, fish may also be temporarily scared away by noise and vibrations. Noises from the construction phase are to be reduced by means of suitable measures. Further local effects on fish fauna may be due to the additional hard substrates introduced owing to a possible change in the benthos. Likewise, sediment warming and the magnetic fields that could emanate from submarine cables are not expected to have any permanent effects on the mobile fish fauna.

Marine mammals

According to the latest information available, it can be assumed that the German EEZ is used by harbour porpoises for crossing and resting, and also as a feeding ground and – in specific locations – as a nursery area. Given the available information, medium to high regional importance of the EEZ for harbour porpoises can be inferred. Use varies in the sub-areas of the EEZ. This also applies to harbour seals and grey seals. Areas 1, 2 and 3 are of medium to high importance for harbour porpoises (seasonal in spring) and of low to medium importance for grey seals and harbour seals. Area 4 is located in the main concentration area of the harbour porpoise identified in the German Bight during the summer months and is therefore of high importance. Area 4 is of medium importance for harbour seals and grey seals. The sites of area 5 are located in a large area which is used both as a feeding and rearing ground for harbour porpoises – even if the focus of concentration is within area I of the "Sylt Outer Reef – Eastern German Bight" nature conservation area. In general, the importance of area 5 for harbour porpoises is considered to be high. Area 5 is of medium importance for harbour seals and grey seals. Areas 6 to 11 are of medium importance for harbour porpoises. However, parts of area 11 and area 13 are intensively used as feeding grounds by harbour porpoises in summer. They are located in the immediate vicinity of the main continuous concentration area of the harbour porpoise in the German Bight and therefore have high importance for harbour porpoises during the summer months. Areas 6 to 13 are of minor importance for harbour seals and grey seals.

Dangers 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 reduction measures, considerable impairments of marine mammals could not be excluded during pile driving. The pile-driving of offshore wind turbines and converter platforms is therefore only permitted in the concrete approval procedure if effective noise mitigation measures are used. For this purpose, the Site Development Plan includes a specification regarding the noise reduction principle.

This means that the installation of the foundations must be carried out with the use of effective noise mitigation measures to comply with the applicable noise protection values. In the specific approval procedure, extensive noise mitigation measures and monitoring measures are prescribed to ensure compliance with the applicable noise protection values (sound event level (SEL) of 160 dB re 1µPa²s and maximum peak level of 190 dB re 1µPa at a distance of 750 m around the pile-driving or installation site). Appropriate measures must be implemented so as 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 reduction show that the use of suitable measures can significantly reduce the effects of noise pollution on marine mammals. The BMU's noise abatement concept has also been in force since 2013. According to the noise abatement concept, pile driving must be coordinated in terms of time in such a way that sufficiently large areas, particularly within the conservation areas and the main concentration area for harbour porpoise in the summer months, are kept free of effects related to pile driving. According to current state of knowledge, significant effects on marine mammals caused by the operation of offshore wind turbines and converter platforms can be excluded.

The exclusion of the construction of offshore wind turbines and converter platforms in Natura 2000 sites, as laid down in the Site Development Plan, contributes to lowering the threat to harbour porpoises in important feeding and rearing areas.

After the mitigation measures prescribed in the individual procedure have been implemented in order to comply with the applicable noise protection values in line with the planning principle, the construction and operation of the planned offshore wind turbines and converter platforms are currently not expected to have any significant adverse effects on marine mammals. The laying and operation of submarine cable systems is not expected to have a significant impact on marine mammals.

Seabirds and resting birds

The individual areas for offshore wind energy in the North Sea EEZ are of differing significance to seabirds and resting birds. For breeding birds, the areas are of no particular importance due to the distance from the coast and the islands, with the breeding colonies as feeding grounds. Protected bird species listed in Annex I of the Birds Directive occur in varying numbers in the vicinity of the areas. All the information available so far indicates medium importance of areas N-1, N-2 and N-3 for seabirds, including species listed in Annex I of the Birds Directive. Area N-4 is actually only of medium importance for most seabird and resting bird types; that said, in spring divers turn up in large numbers in the north-west of the area. Due to its location within the main concentration area of divers, area N-4 is of great importance. Area N-5 has a high occurrence of seabird species, in particular protected species listed in Annex I to the Wild Birds Directive, such as divers, which are sensitive to disturbances. Area N-5 is located in the main distribution area of the divers in the German Bight and is therefore very important for seabirds (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety 2009).

The section of areas N-6 to N-13 lies outside the concentration centres of various species of birds listed in Annex I of the Wild Birds Directive, such as divers, terns, little gulls and common gulls.

Direct disturbances during the construction phase due to deterrence are only to be expected very locally and for a limited time. Significant effects can be excluded with a high degree of certainty due to the high mobility of birds. Wind turbines will cause permanent disturbance and deterrence among disturbance-sensitive species, such as red-throated divers and black-throated divers. Current findings show a more pronounced avoidance behaviour of divers in relation to existing wind farms than was originally anticipated. There have been no findings that the divers acclimatise to the wind farms.

The exclusionary effect of wind turbines and platforms in nature conservation areas means that habitat losses in important habitats are reduced.

Laying, construction-related and operational effects of the planned submarine cable systems on seabirds and resting birds can be excluded with the necessary certainty. A possible collision risk due to construction vehicles can be classified as very low due to the short-term nature of the construction phase.

Migratory birds

The North Sea EEZ is of average to above-average importance for bird migration. It is assumed that considerable numbers of songbirds breeding in Northern Europe migrate across the North Sea. Special migratory corridors cannot be identified for any migratory bird species in the vicinity of the North Sea EEZ, as bird migration takes place either in a guiding principle-oriented coastal area or as broad-front migration over the North Sea that cannot be defined in greater detail. There are indications that the migration intensity decreases with the distance to the coast, but this is not clear for the mass of nocturnally migrating songbirds.

Possible impacts of the planned areas, sites and platforms on migratory birds may be that they constitute a barrier or collision risk. In the clear weather conditions preferred by the birds for migration, the probability of a collision with a wind turbine or platform is very low. Bad weather conditions increase the risk. According to the current state of knowledge, it is not likely that the bird migration will be significantly impaired. It can be assumed that any negative effects can be reduced by lighting that is as compatible as possible during operation. Potential cumulative effects are discussed in the chapter "Cumulative effects".

During the temporary construction phase, neither the construction of the planned offshore wind turbines or converter platforms nor the laying of the planned submarine cable systems are expected to have any significant effects on migratory birds according to the current state of knowledge. A possible collision risk due to construction vehicles can be classified as very low due to the short-term nature of the construction phase.

Bats

Migration movements of bats across the North Sea are still scarcely documented and largely unexplored. There is a lack of specific information on migratory species, migration corridors, migration heights and migration concentrations. Information available to date confirms merely that bats, especially species that travel long distances, fly over the North Sea.

Dangers to individuals due to collisions with wind turbines and platforms cannot be ruled out. According to the current state of knowledge, there are no findings on possible substantial impairments of bat migration over the North Sea EEZ. It can also be expected that any negative effects on bats can be prevented by using the same prevention and mitigation measures devised to protect bird migration. Effects on bats due to the laying and operation of the planned submarine cable systems can be ruled out with certainty.

Air quality

The construction and operation of the platforms and the laying of submarine cable systems as part of the implementation of the Site Development Plan will have no measurable impact on air quality.

Biodiversity

Biodiversity involves the diversity of habitats and communities, the diversity of species and the genetic diversity within species (Art. 2 of the Convention on Biological Diversity, 1992). Public attention is focused on biodiversity.

With regard to the current state of biodiversity in the North Sea, there is a wealth of evidence of changes in biodiversity and species patterns at all systematic and trophic levels in the North Sea. These are mainly due to human activities, such as fishing and marine pollution, or to climate change. In this regard, Red Lists of endangered animal and plant species have an important control and warning function as they indicate the state of populations of species and biotopes in a region. Possible effects on biodiversity are discussed for the individual factors in the environmental report. In summary, it can be stated that according to current knowledge, the planned expansion of offshore wind energy and the corresponding grid connections are not expected to have any significant effects on biodiversity.

Interdependency

In general, effects on a factor lead to various consequences and interrelationships between the factors. The essential interdependence of the biotic factors results from the food chains. Possible interactions during the construction phase will result from sediment shifts and turbidity plumes, as well as noise emissions. However, these interdependencies will occur only very briefly and be limited to a few days or weeks.

Construction-related interrelationships, e.g. due to introduction of hard substrate, will indeed be permanent but are only to be expected locally. This could lead to a small-scale change in the food supply.

Interrelationships can only be described very imprecisely due to the variability of the habitat. In principle, it can be stated that according to the current state of knowledge, no interrelationships are discernible that could endanger the marine environment.

Cumulative effects

Soil, benthos and biotopes

A significant proportion of environmental effects on the factors Soil, Benthos and Biotopes due to the areas and sites, platforms and submarine cable systems will take place solely during the construction period (formation of turbidity plumes, sediment shifts, etc.) and over a limited area. Cumulative environmental effects due to construction are unlikely, particularly due to the step-by-step implementation of the construction projects. Possible cumulative effects on the seabed, which could also have a direct impact on the factor Benthos and specially protected biotopes, result from permanent direct area use due to the foundations of the wind turbines and platforms, as well as from the installed cable systems. The individual impacts are generally small-scale and local.

In order to estimate the direct area use, a rough calculation is made on the basis of the areas and sites, platforms and submarine cable systems planned in the Site Development Plan in conjunction with existing installations and planning within the framework of the transitional system. The calculated area use is based on ecological aspects; in other words, the calculation is based on the direct ecological loss of function or the possible structural change of the site due to the installation of foundations and cable systems. In the area of the cable trench, however, the impairment of the sediment and benthic organisms will essentially be temporary. Permanent impairment could be assumed when crossing particularly sensitive biotopes such as reefs or species-rich gravel, coarse sand and shell layers.

According to a model assumption, there will be a mostly temporary loss of function over a site of around 335 ha due to existing cables, cables in the transitional system and the submarine cable systems provided for in the Site Development Plan. The calculation is based on the assumption of a cable trench 1 m wide. The necessary intersections also have to be taken into account here. Based on an area per intersection of approx. 900 m², the direct area use for approx. 400 intersections amounts to a total of approx. 36 ha. In addition to this, a total of 0.96 ha of area used will be taken up by 16 converter platforms with associated scour protection (600 m² per platform). For the Site Development Plan rules in the areas, the parameters of scenario 2 of the model wind farm were used as a basis for a conservative estimate (number of installations calculated in accordance with the stated capacity, diameter of the foundation and diameter of any scour protection required, number of platforms). In contrast, the model wind farm parameters of scenario 1 were used to calculate area use within the framework of the transitional system, assuming that no installations in the dimension of scenario 2 will be implemented in the transitional system. The functional loss due to the cabling within the wind farm was calculated in accordance with the capacity shown, assuming a cable trench 1 m wide. On the basis of this conservative estimate, approx. 315 ha of land will be used for the areas and sites by means of the Site Development Plan rules, planning within the framework of the transitional system and the existing systems, or temporarily impaired in the case of the farm's internal cabling.

On the basis of a model assumption, the planning of the Site Development Plan and the transitional system as well as the actual inventory of wind turbines, submarine cables, rockfills and platforms mean that a total site of approx. 686 ha will be taken up or, in the case of submarine cables, will be temporarily impaired, corresponding to approx. 0.25‰ of the total EEZ site. The nature conservation sites account for a total area of around 27% of the North Sea EEZ. As construction of wind turbines and converter platforms is generally not permitted in nature conservation areas, use of the protected areas is limited to submarine cable routes and intersections, as well as the exceptional case of Butendiek. No statement can be made on the use of specially protected biotopes according to section 30 of the Federal Nature Conservation Act due to the absence of a sound scientific basis. Detailed area-wide sediment and biotope mapping of the EEZ currently being carried out will provide a more reliable basis for evaluation in the future.

Besides the direct use of the seabed and hence the habitat of the organisms living there, the foundations and intersections will lead to an additional supply of hard substrate. The benthic fauna adapted to soft substrates will also lose habitat on account of the hard substrate. However, as the area use for both the grid infrastructure and the wind farms will be in the ‰ (per-mille) range, according to current knowledge, no significant impairments are to be expected in the cumulation that would endanger the marine environment with regard to the seabed and the benthos.

Marine mammals

Cumulative impacts on marine mammals, harbour porpoises in particular, can occur mainly due to noise emissions during pile-driving of the foundations. These factors could be significantly affected by the fact that – if pile-driving takes place simultaneously at different locations within the EEZ – there is not enough room available to escape and retreat. To date, there has been a lack of sufficient experience regarding the temporal and spatial overlap in the spread of noise from pile-driving.

Cumulative impacts of the Site Development Plan on the harbour porpoise population will be considered in accordance with the requirements of the 2013 noise protection concept of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. Pile-driving work with the potential to cause noise disturbances in the main concentration area of the harbour porpoise during the sensitive season must be coordinated in such a way that the proportion of the affected area remains below 1%.

It is also clear from the descriptions of the Site Development Plan that the grid connection systems and the individual offshore wind farms will be constructed gradually, i.e. in stages, in the coming years and not simultaneously.

Seabirds and resting birds

Vertical structures such as platforms or offshore wind turbines may have different effects on resting birds, such as habitat loss, an increased risk of collision or deterrence and disturbance. These effects are considered under the scope of the environmental impact assessment specific to the location and project, and monitored during the subsequent monitoring of the construction and operation phase of offshore wind farm projects. For resting birds, habitat loss due to cumulative effects of several structures or offshore wind farms can be particularly significant.

Possible effects must be assessed on a species-specific basis in order to assess the significance of cumulative effects on seabirds. In particular, species listed in Annex I of the Wild Birds Directive, species of sub-area II of the "Sylt Outer Reef – Eastern German Bight" nature conservation area and species for which avoidance behaviour with regard to structures has already been established are to be considered with regard to cumulative effects.

When assessing the cumulative effects of implementing offshore wind farms, special consideration must be given to the group of sea divers, which includes the endangered red-throated divers and the black-throated divers, which are also sensitive to disturbances. GARTHE & HÜPPOP (2004) confirm that divers are very sensitive to structures. To assess cumulative effects, both adjacent wind farms and those located in the same contiguous functional spatial unit defined by physically and biologically significant properties for a species must be considered. In addition, the effects of shipping traffic (and for the operation and maintenance of cables and platforms as well) must be included in addition to the structures themselves. Current findings in studies confirm the deterrent effect on divers triggered by ships. The red- and black-throated divers are among the bird species most sensitive to ship traffic in the German North Sea. (MENDEL et al. 2019, FLIESSBACH et al. 2019).

Until 2007, the cumulative effects of offshore wind farms on divers were assessed in the approval practices of the Federal Maritime and Hydrographic Agency on the basis of quantitative criteria and taking into account the existing knowledge at that time. In order to assess the significance of this quantitatively assumed impact and to answer the question as to the existence of the reason for denying the threat to the marine environment, population biological thresholds and a suitable relevant reference value for this threshold were defined. In the literature, it is proposed for birds that an intervention be considered inadmissible if 1% of the biogeographical population is affected by habitat loss. Reference is made to criteria of the 1971 Ramsar Convention on Wetlands of International Importance, according to which a resting area is of international importance if it accommodates at least 1% of the biogeographical population of a waterbird species at least once a year (DIERSCHKE et al. 2003).

This 1% criterion can also be found in the classification of Important Bird Areas (IBA). An area is designated an IBA by Birdlife International if it is home to more than 1% of the biogeographical population (HEATH AND EVANS 2000). However, this 1% Ramsar Convention threshold cannot currently be transferred in terms of population biology for the assessment of the significance of interventions or disturbances (DIERSCHKE et al. 2003). Since the Ramsar Convention uses the 1% criterion to assess the significance of wetlands, the very different intentions mean that it does not appear technically and scientifically justifiable to apply this criterion to the assessment of an intervention.

At the same time, the 1% criterion was regarded as at least suitable for approaching the quantification of an intervention in approval practices until 2007 due to the absence of other reliable criteria. In order to account for the ecological and functional significance of the German EEZ for divers, what is known as the Northwest European winter resting population (NW European winter resting population) was defined as the relevant reference population for the assessment of cumulative effects on divers in consultation with the Federal Agency for Nature Conservation and experts. This population is 110,000 in size (LEOPOLD et al. 1995, SKOV et al. 1995). Applied to the NW European winter resting population, 1% of this population is equivalent to 1,100 individuals.

The addition of the number of affected divers, which was carried out until 2007 as part of the assessment of cumulative effects, also took into account the size of a project area, including a deterrence distance of 2 km.

However, the publication of the results of the operational monitoring of the Danish offshore wind farm "Horn Rev I" in 2006 gave reason to review the assessment of cumulative effects in the light of the new findings. The investigations showed that avoidance effects on divers up to 4 km away from the wind farm were verifiable and significant (PETERSEN et al.2006).

The extensive data available as early as 2007 from German marine areas, consisting of environmental impact studies, research and monitoring, and the findings from the Danish wind farm were evaluated in a scientific study. Based on the new findings of this study, it was possible to identify and delineate a main concentration area for divers in the German North Sea EEZ.

The main concentration area takes into account spring, the most important period for the species. Based on the data available at the time the main concentration area was defined in 2009, the main concentration area was home to about 66% of the German North Sea diver population and about 83% of the EEZ population in spring and is therefore of particular importance in terms of population biology (BMU 2009) and an important functional component of the marine environment in terms of seabirds and resting birds. The importance of the main concentration area for divers in the German North Sea and within the EEZ has increased further against the background of current population calculations (SCHWEMMER et al. 2019). The demarcation of the main concentration area of divers is based on a data availability defined as very good and on technical analyses for which there is broad scientific acceptance. The area includes all regions in the German Bight with very high diver numbers and most of the areas with high diver numbers. The definition of the main concentration area of the divers in the German North Sea EEZ as part of the position paper of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2009) is an important measure to ensure the protection of the species of red- and black-throated divers. The Federal Ministry for the Environment, Nature Conservation, Construction and Nuclear Safety stipulated that in future approval procedures for offshore wind farms the main concentration area should be used as a yardstick for the cumulative assessment of the loss of diver habitat.

Since 2009, the Federal Maritime and Hydrographic Agency has carried out the qualitative assessment of cumulative effects on divers using the main concentration area in accordance with the position paper of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2009) under the scope of approval procedures.

Between 2010 up to and including 2013, a number of approved offshore wind farm projects carried out the third year of the baseline survey as part of implementation. The Federal Agency for Nature Conservation and the Federal Maritime and Hydrographic Agency took the completion of the basic investigations as an opportunity to jointly commission a study to evaluate the findings on the main concentration area, taking into account all data available at that time on the diver population in the German Bight before the start of the construction and operation of offshore wind farms in the German EEZ. The results of the study confirmed the importance and delimitation of the main concentration area of divers in spring (GARTHE et al. 2015).

The current findings from the operational monitoring of offshore wind farms and from research projects, some of which made use of investigation methods independent of standardised monitoring in accordance with the Standard Investigation Concept (StUK) (e.g. telemetry study under the scope of the DIVER project), consistently show that the avoidance behaviour of divers in relation to offshore wind farms is far more pronounced than had been anticipated in the original approval decisions of the wind farm projects (see chapter 4.6.).

The Federal Agency for Nature Conservation and the Federal Maritime and Hydrographic Agency then again commissioned a study under the scope of ongoing research projects to comprehensively and jointly evaluate the extensive data from the operational monitoring of offshore wind farms as well as from research and monitoring of the Natura 2000 sites. The overall goal of the project was to assess the cumulative effects of the operation of the offshore wind farms on the occurrence of divers. Interim results of this Research and Technology Centre study were presented at the Marine Environment Symposium of the Federal Maritime and Hydrographic Agency 2018. The analyses have now been published (GARTHE et al. 2018, SCHWEMMER et al. 2019). The cumulative analysis of the avoidance behaviour of divers in relation to offshore wind farms yielded a calculated total habitat loss of 5.5 km and a statistically significant decrease in abundance up to 10 km away, starting from the periphery of a wind farm (GARTHE et al. 2018). For the statistically significant decrease in abundance, this is not a total avoidance but a partial avoidance with increasing diver densities up to 10 km away from a wind farm. The calculated total habitat loss of 5.5 km is used to quantify the habitat loss, similar to the previous deterrence distance of 2 km. This is subject to the purely statistical assumption that there are no divers up to a distance of 5.5 km from an offshore wind farm.

The current state of knowledge from the above-mentioned study will be taken into account from now on in sectoral planning and in decisions of the Federal Maritime and Hydrographic Agency. The definition of suitable measures will be reviewed in cooperation with the nature conservation authority.

Against this background, based on the calculated total habitat loss of now 5.5 km, 19% of the 7,332 km^2 main concentration area is no longer available for divers due to their avoidance behaviour in relation to the wind farm projects already implemented and analysed in the position paper. Based on the assumptions made in the position paper (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety 2009) of a deterrence distance of 2 km, 9% area loss in the main concentration area was anticipated. This means that already at this point in time, the area-related impairment in this important habitat is greater than originally assumed.

In summary, the results from monitoring and research projects show that the avoidance behaviour of divers in relation to offshore wind farms is much more pronounced than previously assumed. A current population calculation in the main concentration area for the period 2002 to 2012 yielded an increase in the number of red-throated divers, which has remained at a relatively constant high level since 2012. However, a decrease in the red-throated diver population has been recorded since 2012 for the entire German North Sea, the sub-areas of which have different local significance as habitats for divers. These observations illustrate the special functional significance of the main concentration area as a habitat for divers in the German North Sea in view of the pronounced avoidance behaviour and associated habitat loss (SCHWEMMER et al. 2019).

The main concentration area represents a particularly important component of the marine environment with regard to seabirds and resting birds, in particular with regard to the species group of divers. Taking into account the new findings, further cumulative effects on the number of divers can be expected from the implementation of other wind farm projects in the main concentration area. This alone poses a threat to the marine environment pursuant to section 5 subsection 3 WindSeeG, notwithstanding the issue of admissibility under species conservation law. For this reason area N-5.4 may not be designated. Areas N-5 and N-4 were reviewed for subsequent use (see chapters 7.4 and 7.5 of the Site Development Plan). The detailed assessment and justification are explained in chapter 5.2 of the Environmental Report.

Migratory birds

A potential danger for migratory birds results firstly from the collision risk with the individual offshore wind turbines and the platforms and secondly from adverse effects on the fitness of the birds due to forced changes in the flight route.

Under normal migratory conditions preferred by migratory bird species, there is so far no evidence for any species that the birds typically migrate in the danger zone of the turbine and/or do not recognise and avoid these obstacles. In the clear weather conditions preferred by the birds for migration, the probability of a collision with a wind turbine or converter platform is therefore very low.

A potentially dangerous situation is posed by unexpected fog and rain, which lead to poor visibility and low flight altitudes. A particular problem is when bad weather conditions coincide with what are known as mass migration events. The risk of collision for migrating birds and seabirds during the day is generally estimated to be low. They orient themselves visually and are usually able to land on water. The risk of bird strikes could therefore be more likely to occur in large songbird populations that migrate at night.

To prevent or minimise the risk, turbines must be designed so that light emissions are avoided as far as possible during construction and operation, unless they are unavoidable and required by safety requirements for ship and air traffic and occupational safety.

In addition to the risk of bird strikes, the cumulative effects of offshore wind farms in the sites and areas planned in the Site Development Plan and of converter platforms could also lengthen the migratory route for migrating birds. A possible barrier effect could divert the migratory route and thus make it longer. It is a known fact that wind farms are avoided by birds, i.e. they fly around or over them.

Based on existing knowledge about the migratory behaviour of the various bird species, the usual flight altitudes and the daily distribution of bird migration, it is unlikely that the implementation of the Site Development Plan will endanger bird migration. At present, no significant negative effect on the further development of the populations can be expected from possibly flying around the turbines. It must be borne in mind that, based on the current state of science and technology, this forecast is based on premises that are not yet suitable to adequately secure the basis for the factor. Insufficient knowledge exists particularly about species-specific migration patterns. These gaps have not yet been closed despite extensive research activities.

Due to the above-mentioned gaps in knowledge, it is not possible at this stage to make a conclusive cumulative assessment of all offshore wind farms to be considered, including all designated areas and further offshore wind farms outside of the German EEZ.

Transboundary impacts

The SEA comes to the conclusion that as things stand at present, the specifications in the Site Development Plan have no significant effects on the areas of neighbouring states bordering on the German EEZ in the North Sea.

Substantial transboundary impacts can generally be excluded for the factors Landscape, Cultural heritage and Other material assets and Human beings and Human health. Possible substantial transboundary impacts could only arise if considered cumulatively, including all planned wind farm projects in the area of the German North Sea, for the highly mobile factors Fish, Marine mammals, Seabirds and resting birds, as well as Migratory birds and Bats.

The SEA comes to the conclusion that, according to the current state of knowledge, the implementation of the Site Development Plan is not expected to have any substantial transboundary impacts on the factor Fish, since on the one hand the areas for which the Site Development Plan defines rules have no prominent function for fish fauna, and on the other the discernible and predictable effects are small-scale and temporary in nature. According to current knowledge and taking into account measures to minimise impact and limit damage, substantial transboundary impacts can also be ruled out for the factor Marine mammals. The installation of the foundations of wind turbines and converter platforms, for example, is only permitted in the specific approval procedure if effective noise mitigation measures are taken (see 4.4.1.7 Site Development Plan). In the case of the factor Seabirds and resting birds, the Danish bird sanctuary "Sydlige Nordsø", which is directly adjacent to the German EEZ to the north and also has a high occurrence of divers, has to be taken into account when considering possible significant transboundary impacts. The non-designation of area N-5.4 counteracts a possible impairment of the Danish bird sanctuary, including the presence of sea divers there.

For migratory birds, the wind turbines and platforms erected in Site Development Plan sites may constitute a barrier or present a risk of collision. As the platforms are individual structures in the immediate vicinity of offshore wind farms, however, no significant impairment of bird migration due to platforms alone is to be expected. When considering the collision risk posed by wind turbines, the already existing development of some areas must be taken into account in connection with future developments involving new turbine types of larger dimensions. The collision risk must therefore be assessed differently for each specific area. However, final cumulative consideration of the effects on bird migration, including all offshore wind farms to be taken into account, is currently not possible due to a lack of knowledge of the actual collision risk.

Assessment of wildlife conservation regulations

In addition, the environmental report contains a species conservation assessment pursuant to section 44 subsection 1 of the Federal Nature Conservation Act. At the more abstract level of technical planning, it concludes that, according to the current state of knowledge and in strict compliance with avoidance and reduction measures and implementation of the requirements of the noise protection concept, the offshore wind farms, platforms and submarine cable routes planned in the Site Development Plan will not have any significant negative effects that would violate species conservation law.

In order to exclude a significant species protection disturbance as defined by section 44 subsection 1 no. 2 of the Federal Nature Conservation Act, site N-5.4, which was described in the (preliminary) drafts of the Site Development Plan, is excluded from further planning for offshore wind turbines based on the results of the assessment of the cumulative adverse effects on the conservation status of the local population of divers (see chapters 7.4 and 7.5 of the Site Development Plan). Areas N-4 and N-5 will be assessed for subsequent use.

Assessment of the implications

Within the framework of this SEA, the areas, sites, platforms and submarine cable routes in the Site Development Plan will be subject to a separate assessment as to their implications for the conservation objectives of the nature conservation areas.

The German EEZ of the North Sea includes the nature conservation areas "Sylt Outer Reef – Eastern German Bight", "Borkum Reef Ground" and "Dogger Bank", which were established by decree on 22 September 2017. The implications according to the Federal Nature Conservation Act are to be assessed in accordance with the assessment previously carried out for the FFH areas. By a decision made by the EU Commission dated 12.11.2007, the nature conservation areas in the EEZ were previously included under European law as FFH areas in the first updated list of areas of Community importance in the Atlantic biogeographical region under Art. 4 subsection 2 of the Habitats Directive (Official Journal of the EU, 15.01.2008, L 12/1), so an FFH assessment of the implications has already been carried out within the framework of the Spatial Offshore Grid Plan.

Sections 34 and 36 of the Federal Nature Conservation Act stipulate that plans or projects which, individually or in conjunction with other plans or projects, may significantly affect an FFH area and EU bird sanctuary and which do not directly serve the administration of the area must be assessed for their implications for the conservation objectives and protective aims of a Natura 2000 site. This is also applicable to projects outside the site which, individually or in combination with other projects or plans, are likely to significantly undermine the conservation objectives of the sites. With the designation of the nature conservation areas, this assessment now refers to the conservation objective of these nature conservation areas.

The factors as a whole are the habitat types "reefs" and "sandbanks" according to Annex I of the Habitats Directive, certain fish species and marine mammals according to Annex II of the Habitats Directive (mud lamprey, waite, harbour porpoise, grey seal and seal), and various bird species according to Annex I of the Birds Directive (red-throated diver, black-throated diver, little gull, sandwich tern, common tern, Arctic tern, fulmar, gannet, common scoter, great skua, pomarine skua, common gull, lesser black-backed gull, kittiwake, guillemot, razorbill). Species listed in Annex IV of the Habitats Directive, e.g. the harbour porpoise, must be strictly protected everywhere, including outside the defined protected areas.

Within the framework of the Site Development Plan, individual areas and sites, platforms, submarine cable routes and gates are planned in or near the nature conservation sites "Borkum Reef Ground" and "Sylt Outer Reef – Eastern German Bight". Two planned interconnectors cross the "Dogger Bank" nature conservation area.

In addition, the assessment of the implications also takes into account the remote effects of the rules defined within the EEZ on the protected areas in the adjacent 12 nautical mile zone and the adjacent waters of the neighbouring states.

The impact assessment of the Site Development Plan with regard to the strictly protected species harbour porpoise has shown that, according to the current state of knowledge, the possibility of significant impairment of the protective aims of the nature conservation areas can be ruled out with the necessary certainty through implementation of the prescribed noise protection measures.

The Site Development Plan defines various measures to protect divers. In addition to the preventive measure of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2009) involving limitation of offshore wind energy within the main concentration area of divers, the Site Development Plan provides for an avoidance measure by excluding site N-5.4 as specified in the (preliminary) drafts of the Site Development Plan. The exclusion of the "Butendiek" offshore wind farm from any subsequent use also represents an important mitigation measure, which is a direct consequence of Objective 3.5.1 (3) of the North Sea EEZ Spatial Plan Ordinance. According to these provisions, the construction of offshore wind farms in Natura 2000 sites is inadmissible, with the exception of the cases mentioned in the objective. Finally, the assessment requirement for the possible subsequent use of areas N-4 and N-5 constitutes a further monitoring measure.

Taking into account the measures included in the Site Development Plan, which ensure the protection of divers both inside and outside of the "Sylt Outer Reef – Eastern German Bight" nature conservation area, the possibility of significant impairment of the protective aims can be ruled out with the necessary certainty.

Impact assessment of the planned sites, areas and platforms

The assessment of the implications concludes that the possibility of significant impairment of the protective aims on protected species through the construction and operation of offshore wind turbines and transformer and converter platforms within the areas and sites defined in the Site Development Plan can be excluded according to the current state of knowledge, assuming implementation of strict measures to minimise the impact and application of the requirements of the noise protection concept of the Federal Minister for the Environment, Nature Conservation, and Nuclear Safety (2013). To this end, the Site Development Plan defines textual rules, in particular with regard to noise mitigation. A detailed assessment of the implications is part of the individual approval procedure.

Impact assessment of the planned cable routes and gates

Possible effects of submarine cables are usually limited to the laying phase and are therefore limited both temporally and spatially. Impacts on the nature conservation areas in their components relevant to the protective aims or conservation objectives can only be expected if the cable routes run through or in the immediate vicinity of a protected area; according to the current state of knowledge, remote effects cannot be assumed. Therefore, following a detailed preliminary investigation for the assessment of the implications, only cable routes that cross nature conservation areas or run in the immediate vicinity, e.g. directly parallel to the edge of protected areas, are taken into consideration.

Due in particular to small area and short duration of cable laying, the possibility of significant impairment of protective aims with regard to protected species of marine mammals and bird species can be ruled out.

Occurrences of FFH habitat types "reefs" and "sandbanks" or other protected biotopes according to section 30 may be present on individual routes. If the site investigations or the specific approval procedure reveal the presence of particularly sensitive biotopes, efforts should be made to bypass these biotopes. Experiences from the implemented projects "NordLink", "AC Connection Butendiek" or "SylWin1 and SylWin alpha" show that small-scale bypassing of reef occurrences, for example, is at least partially possible within the framework of fine routing in the individual approval procedure.

If it does not appear possible to bypass sensitive FFH habitat types, significant impairment of these biotopes cannot be ruled out at present. It is necessary in the specific individual procedure to check, on the basis of available data from the route surveys, whether there is significant impairment. If new findings are available from route investigations, the routing will be adjusted accordingly when the Site Development Plan is updated.

In order to prevent impairing protected FFH habitat types, an alternative assessment – where appropriate in the light of the principle of proportionality – has been carried out for all routes that make use of protected areas and for which it is possible to bypass the protected area.

The possibility of significant impairment of the FFH habitat types "reefs" and "sandbanks which are slightly covered by sea water all the time" can be excluded according to the current state of knowledge, even with cumulative assessment of the plan and already existing projects for the assessed nature conservation areas.

Measures to prevent, mitigate and offset significant negative effects of the Site Development Plan on the marine environment

The measures planned in order to prevent, mitigate and – as far as possible – offset significant negative environmental effects resulting from the implementation of the Site Development Plan are presented in accordance with the requirements of the SEA Directive.

Essentially, the rules of the Site Development Plan will prevent negative effects on the development of the state of the environment of the North Sea EEZ. If the plan were not implemented, the uses would develop without the space-saving and resource-conserving steering and coordination effect of the Site Development Plan.

In specific terms, the Site Development Plan defines spatial and textual rules which, according to the environmental protection objectives set out in chapter 1.4 of the environmental report, serve to prevent or mitigate significant negative effects in the marine environment due to implementation of the Site Development Plan. This essentially concerns textual rules in respect of space-saving planning, preventing the use of protected areas and legally protected biotopes in accordance with section 30 of the Federal Nature Conservation Act, noise mitigation, compliance with the 2K criterion, dismantling of structures and consideration of best environmental practice, as well as the relevant state of the art.

Mitigation and prevention measures are specified and ordered by the competent licensing authority at project level for the planning, construction and operation phases. With regard to the planned sites for wind turbines and platforms, this applies in particular to noise mitigation and noise prevention measures, as well as eco-friendly lighting during operation of the structures. Measures for prevention and mitigation of possible effects of submarine cable systems must be taken into account during the route planning and technical design stages. The Site Development Plan includes a planning principle relating to sediment warming so as to prevent considerable negative effects of cable warming on the benthos.

Examination of alternatives

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

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

In detail, this environmental report examines spatial and technical alternatives in addition to the zero alternative.

Measures envisaged for monitoring the environmental impacts

The potential significant effects on the environment resulting from the implementation of the Site Development Plan are to be monitored in accordance with section 45 subsection 1 UVPG. The aim is to identify unforeseen adverse effects at an early stage and take appropriate remedial action. Monitoring also serves to review the gaps in knowledge presented in the environmental report and the forecasts which contain uncertainties. Pursuant to section 45 subsection 4 UVPG, the results of monitoring are to be taken into account in the update of the Site Development Plan. The actual monitoring of potential impacts on the marine environment can only start when the uses regulated under the plan are in place. Project-related monitoring of the impacts of offshore wind farms, platforms and submarine cable systems is therefore of particular importance. The primary aim of monitoring is to compile and evaluate the findings from the various monitoring results at the project level. Existing national and international monitoring programmes must also be taken into account, also with a view to preventing duplication of work.

The investigation of the potential environmental impacts of areas and sites for offshore wind energy or platforms must be carried out at project level in accordance with the standard "Investigation into the impacts of offshore wind turbines" (StUK 4)" and in coordination with the Federal Maritime and Hydrographic Agency. Monitoring during construction of foundations by means of pile-driving work involves measuring underwater noise and acoustic recordings of the effects of pile-driving noise on marine mammals using POD measuring instruments. In addition, additional monitoring measures are planned to assess the effects of the stratification of the water under certain hydrographic conditions on the spread of noise from pile-driving in the Baltic Sea and, if necessary, to take further measures.

The Federal Maritime and Hydrographic Agency implements a whole range of projects as part of its accompanying research into the possible impacts of offshore wind turbines on the marine environment. These include the ANKER project "Approaches to cost reduction in the surveying of monitoring data for offshore wind farms", R&D study BeMo "Evaluation approaches for underwater noise monitoring in connection with offshore licensing procedures, spatial planning and the Marine Strategy Framework Directive" and various sub-projects within the R&D cooperation, NavES "Eco-friendly offshore developments". The results from the current projects of the Federal Maritime and Hydrographic Agency will be directly incorporated into the further development of standards and norms, such as the development of the StUK5.

The StUK4 for the first time also contains monitoring requirements for the investigation of submarine cable routes with regard to benthos, biotope structure and biotope types during the baseline survey and the operational phase. Identified suspected sites of biotopes that are protected in accordance with section 30 of the Federal Nature Conservation Act must also be examined in terms of spatial delimitation in accordance with the current mapping instructions from the Federal Agency for Nature Conservation. After the cable system has been laid, its position must be checked by means of operational monitoring measures. Investigations of the benthic communities on the same transects as in the baseline survey are to be carried out one year after commissioning of the submarine cable systems.

Consolidation of information creates an increasingly solid basis for impact forecasting. The research projects serve the continuous further development of a uniform, quality-assured basis of marine environmental information for the assessment of possible impacts of offshore installations and form an important basis for updating the Site Development Plan.

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