Nomination of the Dutch-German Wadden Sea as World Heritage Site

WADDEN SEA ECOSYSTEM No. 24 - 2008

Nomination of the Dutch-German Wadden Sea as World Heritage Site

Nomination dossier to the UNESCO for inscription into the World Heritage List

Colophon

Editors
Common Wadden Sea Secretariat (CWSS), Wilhelmshaven, Germany
World Heritage Nomination Project Group (WHNPG)

Language support
Susan Beddig

Cover photo
Mosaic of satellite images of the period 2000-2002
(Source: Eurimage, Common Wadden Sea Secretariat
& Brockmann Consult)

Lay-out
Common Wadden Sea Secretariat

Graphic support
Gerold Lüerßen

Print
Plakativ Grafische Medien GmbH,
Kirchhatten, tacke@plakativ.org

Paper
Cyclus - 100% Recycling Paper

Number of copies
1000

Published
2008

ISSN 0946-896X

This publication should be cited as:
Common Wadden Sea Secretariat, World Heritage Nomination Project Group, 2008. Nomination of the Dutch-German Wadden Sea as World Heritage Site. Wadden Sea Ecosystem No. 24. Common Wadden Sea Secretariat, Wilhelmshaven, Germany.

WADDEN SEA ECOSYSTEM No. 24

Nomination of the Dutch-German Wadden Sea as World Heritage Site

Nomination dossier to the UNESCO for inscription into the World Heritage List

2008
Common Wadden Sea Secretariat
World Heritage Nomination Project Group

Editorial Foreword

The Nomination of the Dutch-German Wadden Sea as World Heritage Site was submitted to the World Heritage Centre, UNESCO, Paris on 30 January, 2008 for inscription on the World Heritage List.

The nomination dossier encompasses two volumes, additionally a set of 37 topographical maps with a scale of 1:50.000 and a DVD with photos of the nominated property.

Volume one is the actual nomination of the Wadden Sea according to the format stipulated by the World Heritage Centre. Volume two encompasses the annexes for the nomination such as expert statements, scientific information and publications, laws and regulations, Ministerial Declarations, bibliography, etc.

Since the dossier provides an up-to-date detailed account of the outstanding values and the protection and management of the Dutch-German Wadden Sea, it has been decided to publish it for the information of the general public.

The present publication is volume one plus three annexes of volume two of the dossier. The three annexes are three experts statements on the outstanding geomorphological and ecological values of the Wadden Sea, and a comparative analysis of the Wadden Sea with similar sites world wide.

All further annexes of volume two of the dossier, including the 37 detailed topographic maps, but excluding GIS data and the photo DVD, can be found on the included CD-ROM.

The nomination dossier, as submitted to the UNESCO World Heritage Centre, can be consulted at http://www.waddensea-secretariat.org/management/whs/whs.html.

Many, many people have worked on and contributed to the elaboration of the nomination dossier. There are too many to name them all personally. We would like to express our deepest gratitude and appreciation for their knowledge, help and support to finalize the dossier in the planned time schedule.

The Editors

Foreword

We are pleased to submit to UNESCO the nomination of the Dutch-German Wadden Sea for inscription into the World Heritage List.

The submission fills us with a great deal of pride. This nomination reflects 15 years of discussion with a wide range of stakeholders and local residents. These discussions have created a firm foundation of support and signify a shared responsibility for the future of the Wadden Sea as a World Heritage Site. Naturally, we are also proud to submit the nomination because the Wadden Sea is undeniably unique. It forms the largest unbroken system of tidal sand and mudflats world-wide, with dynamic processes proceeding in a largely unimpaired way, with spectacular biodiversity of global importance.

For more than a generation our countries have invested huge efforts to protect, conserve and wisely manage the Wadden Sea, both on the regional and national level, and in the context of our common cooperation. We are convinced that we have reached a stage of coordinated trans-boundary protection, management and monitoring that is unprecedented throughout Europe.

The inscription into the World Heritage List would both recognise and reinforce the efforts which the people living, working and enjoying the area, together with us as governments, have made during the latter part of the last century to conserve this area for present and future generations. World Heritage status would also strengthen the regional identity and positively present the region globally.

By focusing on the many day to day challenges and pressures we sometimes overlook the sheer scale and beauty of such a majestic landscape. As has been stated in the nomination dossier walking across the Wadden Sea tidal flats where just a few hours before it was covered by meters of water, surrounded by an endless sky that meets the sea in a distant horizon is an unforgettable experience. Or to see in spring and autumn the huge flocks of birds passing through the Wadden Sea displaying their acrobatic flights like the thousands of knot; or the huge flocks of brent geese, dark against the clear sky, their babbling calls growing in intensity as they approach and dive into the salt marshes to feed in spring before they leave for the remote areas of Siberia. It is a truly magical place – somewhere people can enjoy life changing experiences of nature.

We hope that the nomination will result in a positive decision on the inscription of the Wadden Sea into the World Heritage List. This will signify an international recognition of the Wadden Sea and at the same time, we believe, it will contribute to the List by including a unique trans-boundary wetland ecosystem at the interface of land and sea.

Gerda Verburg
Minister of Agriculture, Nature and Food Quality, The Netherlands

Sigmar Gabriel
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Germany

Christian Wulff
Prime Minister of Niedersachsen

Peter Harry Carstensen
Prime Minister of Schleswig-Holstein

Contents

ANNEXES

The following Annexes are compiled on the enclosed CD-ROM

State parties

The Netherlands and Germany.

State, province or region

The Netherlands: Provinces of Noord Holland, Fryslân, Groningen.
Germany: Federal states of Niedersachsen and Schleswig-Holstein.

Name of property

"THE WADDEN SEA"

Geographical coordinates to the nearest second

The geographical coordinates to the nearest second are in Table S1.

Textual description of the boundaries of the nominated property

The nominated property "The Wadden Sea" encompasses the Dutch Wadden Sea Conservation Area, subject to the Key Planning Decision (PKB) Third Policy Document on the Wadden Sea[1], and the German Wadden Sea National Parks of Niedersachsen and Schleswig-Holstein. In parts of the area the islands or major parts of the islands are not within the nominated property. The nominated property covers an area of 9,735.6 km². The underlying approach of the conservation and sustainable use of the nominated property is an ecosystem approach. All habitats which belong to the Wadden Sea – salt marshes, tidal areas including the tidal inlets, channels and gullies, beaches and dunes, estuaries and offshore areas - are encompassed by the conservation regime in order to protect the ecological processes that are fundamental to the conservation of the system and its flora and fauna. Within the overall comprehensive protection regime, the nominated property is comprised of different protection zones. The zones providing the strictest protection are e.g. the main haul-out sites for harbour and grey seals and high water roosts and breeding sites for birds. These areas are closed for access the whole or part of the year. Outside these strictly protected areas, admission and use of the area is allowed, basically on the condition that these activities do not adversely affect the area and its ecological and landscape values. In addition, several activities are regulated in time and space.

The Wadden Sea Plan, as outlined in chapter 5.e, is valid for the Trilateral Wadden Sea Cooperation Area, in short the Wadden Sea Area. The Wadden Sea Area includes the nominated property and is delimited by 3 nautical miles offshore, with the exception of areas off the East Friesian islands and off the islands of Sylt and Amrum, where the delimitation goes beyond the 3 nautical miles up

Site Element	Name	Coordinates of Centre Points	Size in Hectare	Size in km²	Map No. 1:50,000
001	Key Planning Decision (PKB) Wadden Sea, part I	53° 23' 27" N 05° 39' 57" E	248,883	2,488.8	NL3/18 - NL18/18
002	Key Planning Decision (PKB) Wadden Sea, part II	53° 22' 00" N 06° 53' 47" E	779	7.8	NL1/18 - NL3/18
003	Key Planning Decision (PKB) Wadden Sea, part III / National Park Wadden Sea Niedersachsen, part I	53° 16' 31" N 07° 09' 49" E	8,875	88.8	NL1/18 D17/19
004	National Park Wadden Sea Niedersachsen, part II	53° 41' 44" N 07° 19' 57" E	166,650	1,666.5	D15/19 - D19/19
005	National Park Wadden Sea Niedersachsen, part III	53° 37' 40" N 08° 15' 50" E	49,134	491.3	D13/19 - D14/19
006	National Park Wadden Sea Niedersachsen, part IV	53° 50' 48" N 08° 26' 01" E	59,627	596.3	D11/19 - D13/19
007	National Park Wadden Sea Schleswig-Holstein	54° 31' 43" N 08° 33' 22" E	439,614	4,396.1	D1/19 -D10/19
	Total Property		**973,562**	**9,735.6**	

Table S1: Coordinates of the centre points of the site elements of the nominated property.

1____Excluding the so called disputed area in the Ems-Dollard Estuary

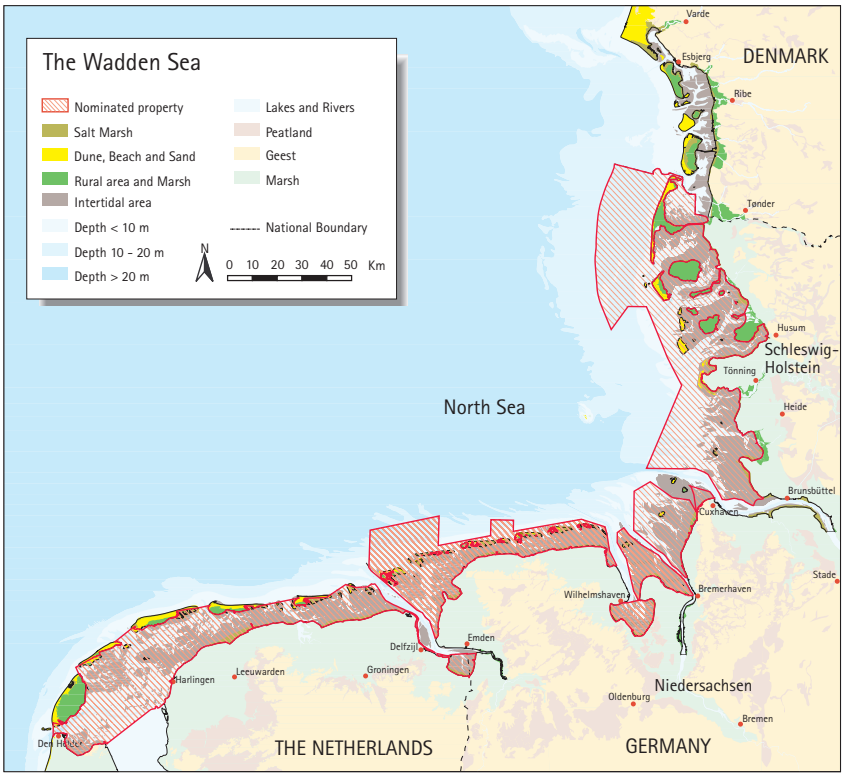


Figure S1:
Map of the nominated property (A3 map see chapter 1).

to 12 nautical miles, the seawalls of the mainland or - where the main dike is absent - the spring high tide water line, the brackish water limits of the rivers Ems, Weser and Elbe and inland Ramsar and NATURA 2000 areas.

The purpose of the buffer zone according to paragraph 104 of the Operational Guidelines is to provide an extra layer of protection to the property. The size of the nominated property, the scope and span of the regulations in place and international agreements and regulations, both in space and scope, ensure the integrity of the nominated property and fully meet the intent of paragraph 104 of the Operational Guidelines. The EC Habitats Directive stipulates, for example, that any plan or project, either within or outside of the nominated property, likely to have a significant effect on it shall be subject to appropriate assessment of its implications for the site. Therefore, a buffer zone to the nominated property has not and will not be designated.

Justification. Statement of Outstanding Universal Value

The Wadden Sea forms the largest unbroken system of tidal sand and mud flats worldwide with natural dynamic processes proceeding in a widely unimpaired natural state. It is one of a kind on earth. The Wadden Sea ecosystem represents one of the most important international wetland habitats that provide the basis for exceptional high biological production, species diversity and a high degree of ecological specialization and potential for adaptation.

It is an outstanding example of the ongoing Holocene development of a sandy coast under conditions of rising sea level and is unique in that it is the largest extensive tidal flat and barrier island depositional system in the World. Its geological and geomorphological features are closely entwined with biophysical processes and provide an invaluable record of the ongoing dynamic adaptation of coastal environments to global change. The biogeomorphological interactions are notably strong and unique at all scales.

The high primary and secondary production in the Wadden Sea sustains species of birds, fish and crustaceans and seals well beyond its borders. The rich and diverse habitats are of outstanding international importance as an essential habitat for migratory water birds using the East Atlantic Flyway and other migration routes between South Africa, Northeast Canada, and northern Siberia. It is one of the few shallow seas in the Northern Hemisphere with a high production of fish and serves as an essential spawning, feeding and nursery area for species migrating between freshwater and saltwater.

The mosaic of natural phenomena including the complex geomorphological features and biologically diverse and rich habitats, the unparalleled vastness and expanse in terms of the spatial dimension and the millions of migratory birds passing through in spring and autumn combine to form an exceptional and beautiful land and seascape.

The nominated property encompasses all the biophysical and ecosystem processes that characterise a natural and sustainable Wadden Sea. The standards of protection, management including coastal protection measures, and monitoring ensure that the natural Wadden ecosystem, with all its component parts, will continue to evolve naturally and to sustain human uses. Man's use of the natural resources in a sustainable way including small-scale traditional uses is a key to help guarantee its integrity for generations to come.

Criteria under which the property is nominated

The Wadden Sea represents a natural system of outstanding universal value based on the following inscription criteria:

Criterion viii: *"be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features"*

The Wadden Sea has evolved over the last 8,000 years being a very young ecosystem in geomorphological and evolutionary terms. It represents an outstanding example of the Holocene development of a temperate-climate sandy barrier coast under conditions of rising sea level. The Wadden Sea is unique in that it consists entirely of a sandy-muddy tidal system with only minor river influences on morphodynamics. The Wadden Sea ecosystem is characterised as tidal flats and barrier island system with extensive salt marshes. The Wadden Sea differs from other systems of this type in that it is the only tidal flat and barrier island depositional system of this scale and diversity in the World.

There are no systems in the World that compare to the Wadden Sea.

The Wadden Sea contains very fine examples of post-glacial coastal geomorphology and the dynamic interaction of physical and biological processes on a scale that is not found within one unified system anywhere else in the world. Despite man-made interventions the continuing presence of these dynamic natural processes ensures the development and rejuvenation of landforms including the whole range of habitats, and secures the maintenance of ecosystem functions. The Wadden Sea ecosystem will thus continue to serve as an important bio-physical reference for the study of the effect of sea level rise and it will be important to consider this function as a legitimate part of the World Heritage concept.

Criterion ix: *"be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals"*

The Wadden Sea is a unique coastal ecosystem with enormously productive marine biota and with linkages far beyond its narrow geographical boundaries. It is one of the last remaining natural large-scale inter-tidal ecosystems in Europe where natural processes continue to function in an undisturbed manner. Excellent and broad scale examples of biogeomorphological processes can be found in the coastal dunes, the salt marshes, and on the tidal flats on mussel beds and sea grass meadows. This transitional environment between land and sea is characterized by the constant change of flood and ebb tides, great fluctuations in salinity, high temperatures during summer and occasional ice cover in winter. These circumstances have created numerous ecological niches, colonized by species that are adapted to the extreme environmental conditions.

The Wadden Sea is an ecological transition zone between land and ocean. With its estuaries, marshes and particularly its wide intertidal zone intersected by deep gullies, the Wadden Sea functions as a gigantic coastal filter system. Freshwater and marine waters are mixed and flushed to and fro with the tides, transporting huge amounts of sediments, organic matter and nutrients. These riverine and marine imports of materials form the basis of the trophic system. Imported organic material is mineralized in the marshes, tidal flats sediment and shallow waters. The release of nutrients from this spacious purification plant, together with those nutrients supplied from the catchment area and the Atlantic waters, fuels outstanding primary production. Due to the active biota, this filter never clogs but is continuously renewed.

Criterion x: *"contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation"*

The tidal flats in the Wadden Sea form the largest unbroken stretch of sand and mudflats worldwide, accounting for 60% of all tidal areas

in Europe and North Africa. As such it is 'the only one of its kind' and many textbooks refer to the Wadden Sea when describing inter-tidal habitats and the rich and diverse flora and fauna they sustain. The tidal flats and the salt marshes form the largest coherent habitat of this type in Europe and constitute an essential element of the Wadden Sea ecosystem.

The Wadden ecosystem represents one of the internationally most important wetlands. It is internationally recognised as a biologically highly productive ecosystem of great natural, scientific, economic and social importance.

The Wadden Sea is extremely rich in environmental gradients and transitional zones, yielding many different (micro) habitats that form the basis for ecological specialization under extreme conditions. The salt marshes host about 2,300 species of flora and fauna. The marine and brackish areas support a further 2,700 species. In total it is estimated that the Wadden Sea Area provides habitats for up to 10,000 species of unicellular organisms, plants, fungi and animals.

The large size of the Wadden Sea allows the diverse species to survive by spreading over several habitats, or by adopting a series of niches over the course of time. This constantly opens up territory for use by other individuals or species, and accounts for a high capacity to accommodate migratory species.

The rich and diverse habitats are of outstanding international importance for birds as staging, moulting and wintering areas. According to the 1% criterion of the Ramsar-Convention, which is an internationally recognized measure to identify wetlands of international importance, the Wadden Sea is of outstanding international importance as a staging, moulting and wintering area for at least 52 populations of 41 migratory waterbird species that use the East Atlantic flyway and originate from breeding populations as far away as northern Siberia or Northeast Canada. Numbers of 44 populations of 34 species are so high, that the Wadden Sea is indispensable and often main stepping stone during migration, or as their primary wintering or moulting habitat. Therefore the Wadden Sea is essential for the existence of these bird species. A severe deterioration of the Wadden Sea implies a biodiversity loss on a worldwide scale.

Name and contact information of official local institution/agency

The Netherlands

Ministry of Agriculture, Nature and Food Quality
Regional Policy Department Northern Office
Mr Hendrik Oosterveld
6, Cascadeplein
NL 9700 RM Groningen
phone: +31(0)50 5992300
fax: +31(0)50 5992399
h.r.oosterveld@minlnv.nl

Germany

Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU)
Ms Christiane Paulus
Robert Schumann-Platz 3
D 53175 Bonn
phone: +49(0)1888 3052630
fax: +49(0)1888 3052684
christiane.paulus@bmu.bund.de

Niedersachsen

Niedersächsisches Umweltministerium
Ref. 52 - Natura 2000, Nationalparke, Biosphärenreservate –
Mr Hubertus Hebbelmann
Archivstraße 2
D 30169 Hannover
phone: +49(0)511 1203382
fax: +49(0)511 120993382
hubertus.hebbelmann@mu.niedersachsen.de

Nationalparkverwaltung Niedersächsisches Wattenmeer
Mr Hubert Farke
Virchowstr.1
D 26382 Wilhelmshaven
phone: +49(0)4421 911281
fax: +49(0)4421 911280
hubert.farke@nlpv-wattenmeer.niedersachsen.de

Schleswig-Holstein

Ministerium für Landwirtschaft, Umwelt und ländliche Räume des Landes Schleswig-Holstein
Ref. 43 Meeresschutz, Nationalpark
Ms Vera Knoke
Mercatorstr. 3
D 24106 Kiel
phone: +49(0)431 9887196
fax: +49(0)431 988 6157196
vera.knoke@mlur.landsh.de

Landesbetrieb für Küstenschutz, Nationalpark und Meeresschutz, Nationalparkverwaltung
Mr Klaus Koßmagk-Stephan
Schlossgarten 1
D-25832 Tönning
phone: +49(0)4861 61640
fax: +49(0)4861 61651
Klaus.Kossmagk-Stephan@lkn.landsh.de

1. IDENTIFICATION OF THE PROPERTY

1.a Country

The Netherlands and Germany.

1.b State, province or region

The Netherlands: Provinces of Noord Holland, Fryslân, Groningen.
Germany: Federal states of Niedersachsen and Schleswig-Holstein.

1.c Name of property

"THE WADDEN SEA"

1.d Geographical coordinates to the nearest second

The geographical coordinates to the nearest second are in Table 1.1.

An A3 overview map on the following page indicates the distribution of the 37 detailed topographical maps 1:50,000, which are in **Annex 21** (for the further off-shore area topographical data is not always available).

The nominated property "The Wadden Sea" encompasses the Dutch Wadden Sea Conservation Area[1], subject to the Key Planning Decision (PKB) Third Policy Document on the Wadden Sea, and the German Wadden Sea National Parks of Niedersachsen and Schleswig-Holstein. In parts of the area the islands or major parts of the islands are not within the nominated property. The nominated property covers an area of 9,735.6 km² The underlying approach of the conservation and sustainable use of the nominated property is an ecosystem approach. All habitats which belong to the Wadden Sea – salt marshes, tidal areas including the tidal inlets, channels and gullies, beaches and dunes, estuaries and offshore areas - are encompassed by the conservation regime in order to protect the ecological processes that are fundamental to the conservation of the system and its flora and fauna. Within the overall comprehensive protection regime, the nominated property is comprised of different protection zones. The zones providing

Table 1.1: Coordinates of the centre points of the site elements of the nominated property.

Site Element	Name	Coordinates of Centre Points	Size in Hectare	Size in km²	Map No. 1:50,000
001	Key Planning Decision (PKB) Wadden Sea, part I	53° 23' 27" N 05° 39' 57" E	248,883	2,488.8	NL3/18 - NL18/18
002	Key Planning Decision (PKB) Wadden Sea, part II	53° 22' 00" N 06° 53' 47" E	779	7.8	NL1/18 - NL3/18
003	Key Planning Decision (PKB) Wadden Sea, part III / National Park Wadden Sea Niedersachsen, part I	53° 16' 31" N 07° 09' 49" E	8,875	88.8	NL1/18 D17/19
004	National Park Wadden Sea Niedersachsen, part II	53° 41' 44" N 07° 19' 57" E	166,650	1,666.5	D15/19 - D19/19
005	National Park Wadden Sea Niedersachsen, part III	53° 37' 40" N 08° 15' 50" E	49,134	491.3	D13/19 - D14/19
006	National Park Wadden Sea Niedersachsen, part IV	53° 50' 48" N 08° 26' 01" E	59,627	596.3	D11/19 - D13/19
007	National Park Wadden Sea Schleswig-Holstein	54° 31' 43" N 08° 33' 22" E	439,614	4,396.1	D1/19 -D10/19
	Total Property		**973,562**	**9,735.6**	

1___Since Medieval times, the Netherlands and Germany have had different opinions on the exact location of the border between both countries in the Ems-Dollard Estuary. The bilateral cooperation on different issues in this so-called disputed area is regulated by the Ems-Dollard Treaty (1960) and the Environmental Protocol (1996). Both countries will develop a first common management plan with regard to the protection of habitats in the forthcoming years. The disputed area, which is part of the Dutch Key Planning Decision (PKB) Third Policy Document Wadden Sea, is hence not part of the nominated property.

1.e Maps and plans, showing the boundaries of the nominated property

Figure 1.1 (left): The North Sea region with the Wadden Sea Area.

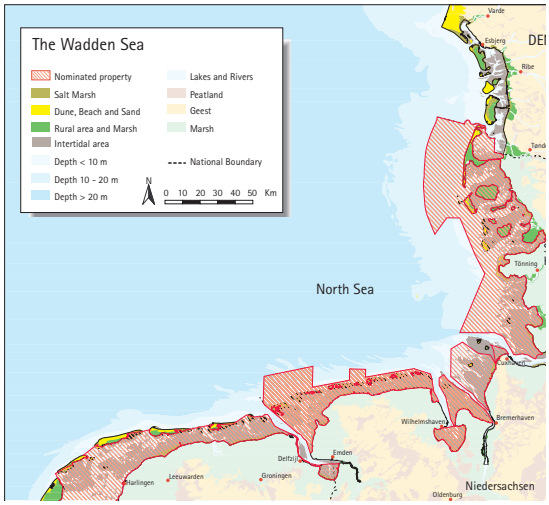


Figure 1.2 (right): The Wadden Sea.

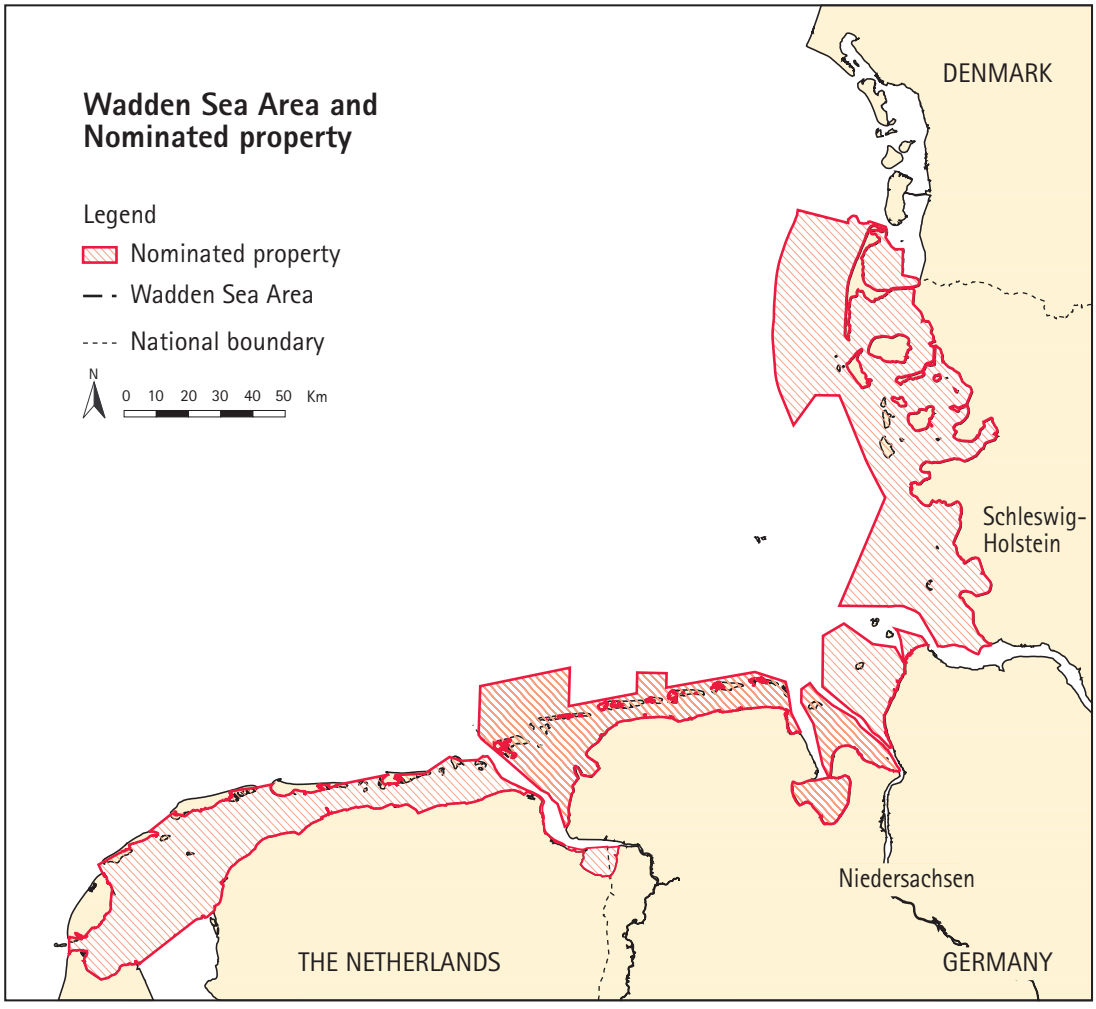


Figure 1.3: Wadden Sea Area and nominated property.

Table 1.2: Coordinates of prominent points of the 7 site elements of the nominated property.

Site element	Name	Prominent Points (see A3 map)	Latitude N	Longitude E
001	Key Planning Decision (PKB) Wadden Sea, part I	**1.1**	53° 33' 33"	06° 36' 03"
		1.2	53° 25' 47"	05° 25' 26"
		1.3	52° 57' 13"	04° 43' 15"
		1.4	53° 19' 16"	05° 45' 16"
		1.5	53° 27' 48"	06° 49' 58"
		Centre point	53° 23' 27"	05° 39' 57"
002	Key Planning Decision (PKB) Wadden Sea, part II	**2.1**	53° 27' 41"	06° 50' 32"
		2.2	53° 19' 03"	06° 59' 48"
		Centre point	53° 22' 00"	06° 53' 47"
003	Key Planning Decision (PKB) Wadden Sea, part III / National Park Wadden Sea Niedersachsen, part I	**3.1**	53° 19' 05"	07° 14' 53"
		3.2	53° 18' 49"	07° 00' 46"
		3.3	53° 15' 58"	07° 04' 18"
		3.4	53° 13' 58"	07° 12' 32"
		Centre point	53° 16' 31"	07° 09' 49"
004	National Park Wadden Sea Niedersachsen, part II	**4.1**	53° 48' 44"	07° 00' 00"
		4.2	53° 37' 03"	06° 34' 51"
		4.3	53° 22' 08"	06° 59' 50"
		4.4	53° 34' 17"	07° 05' 14"
		4.5	53° 41' 02"	07° 28' 40"
		4.6	53° 38' 47"	08° 05' 29"
		4.7	53° 47' 08"	08° 01' 04"
		4.8	53° 48' 13"	07° 27' 23"
		Centre point	53° 41' 44"	07° 19' 57"
005	National Park Wadden Sea Niedersachsen, part III	**5.1**	53° 46' 58"	08° 07' 57"
		5.2	53° 30' 27"	08° 03' 34"
		5.3	53° 23' 26"	08° 12' 33"
		5.4	53° 31' 14"	08° 13' 53"
		5.5	53° 36' 35"	08° 19' 13"
		5.6	53° 32' 31"	08° 33' 30"
		Centre point	53° 37' 40"	08° 15' 50"
006	National Park Wadden Sea Niedersachsen, part IV	**6.1**	53° 56' 10"	08° 32' 09"
		6.2	53° 57' 00"	08° 17' 16"
		6.3	53° 54' 32"	08° 11' 19"
		6.4	53° 46' 25"	08° 11' 32"
		6.5	53° 36' 23"	08° 31' 19"
		6.6	53° 53' 19"	08° 41' 07"
		Centre point	53° 49' 28"	08° 24' 53"
007	National Park Wadden Sea Schleswig-Holstein	**7.1**	55° 06' 04"	08° 02' 42"
		7.2	54° 30' 04"	08° 02' 20"
		7.3	54° 18' 06"	08° 28' 51"
		7.4	53° 59' 58"	08° 16' 03"
		7.5	53° 53' 29"	08° 59' 07"
		7.6	54° 31' 31"	08° 59' 08"
		7.7	54° 54' 02"	08° 38' 16"
		Centre point	54° 31' 43"	08° 33' 22"

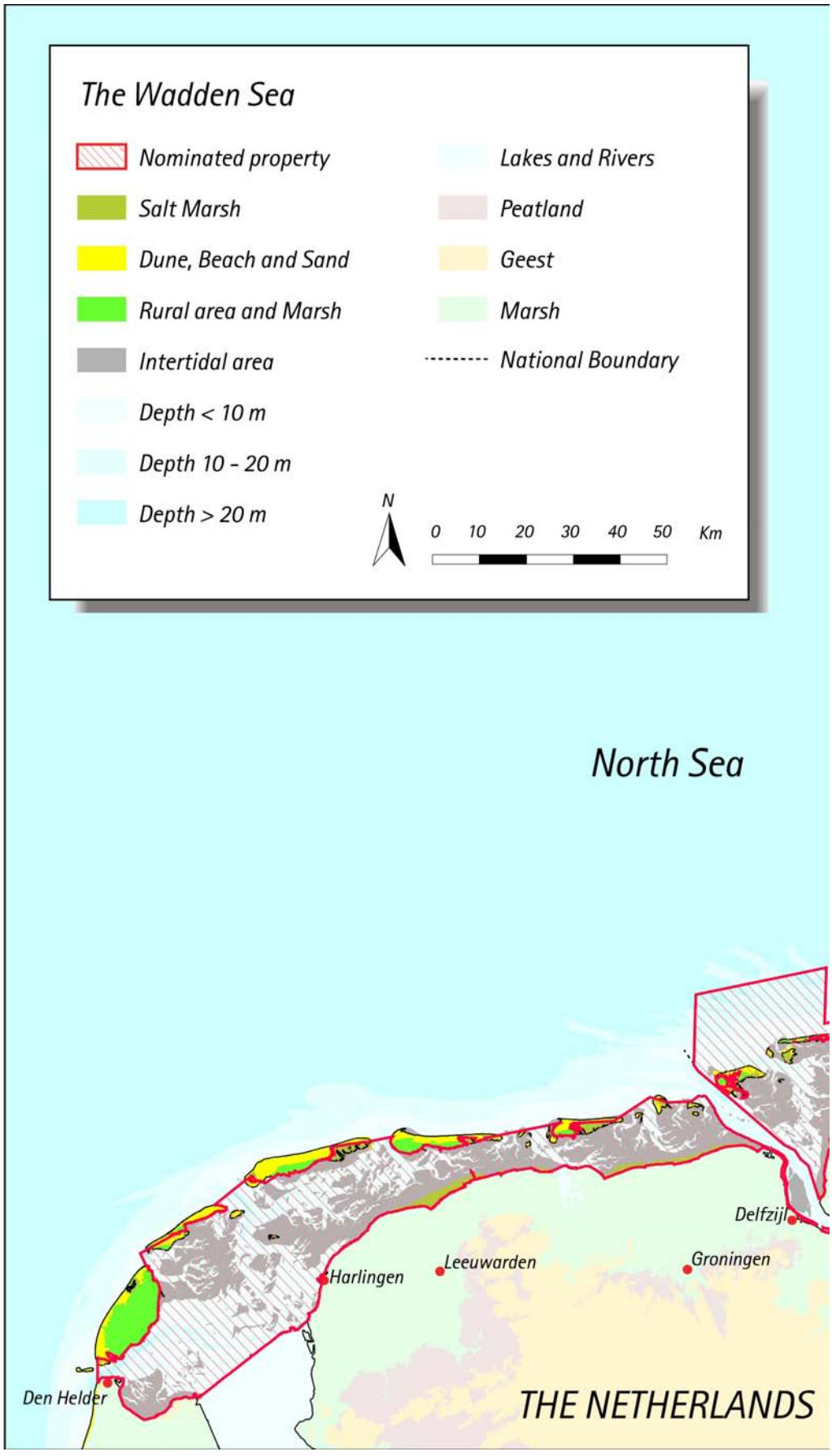
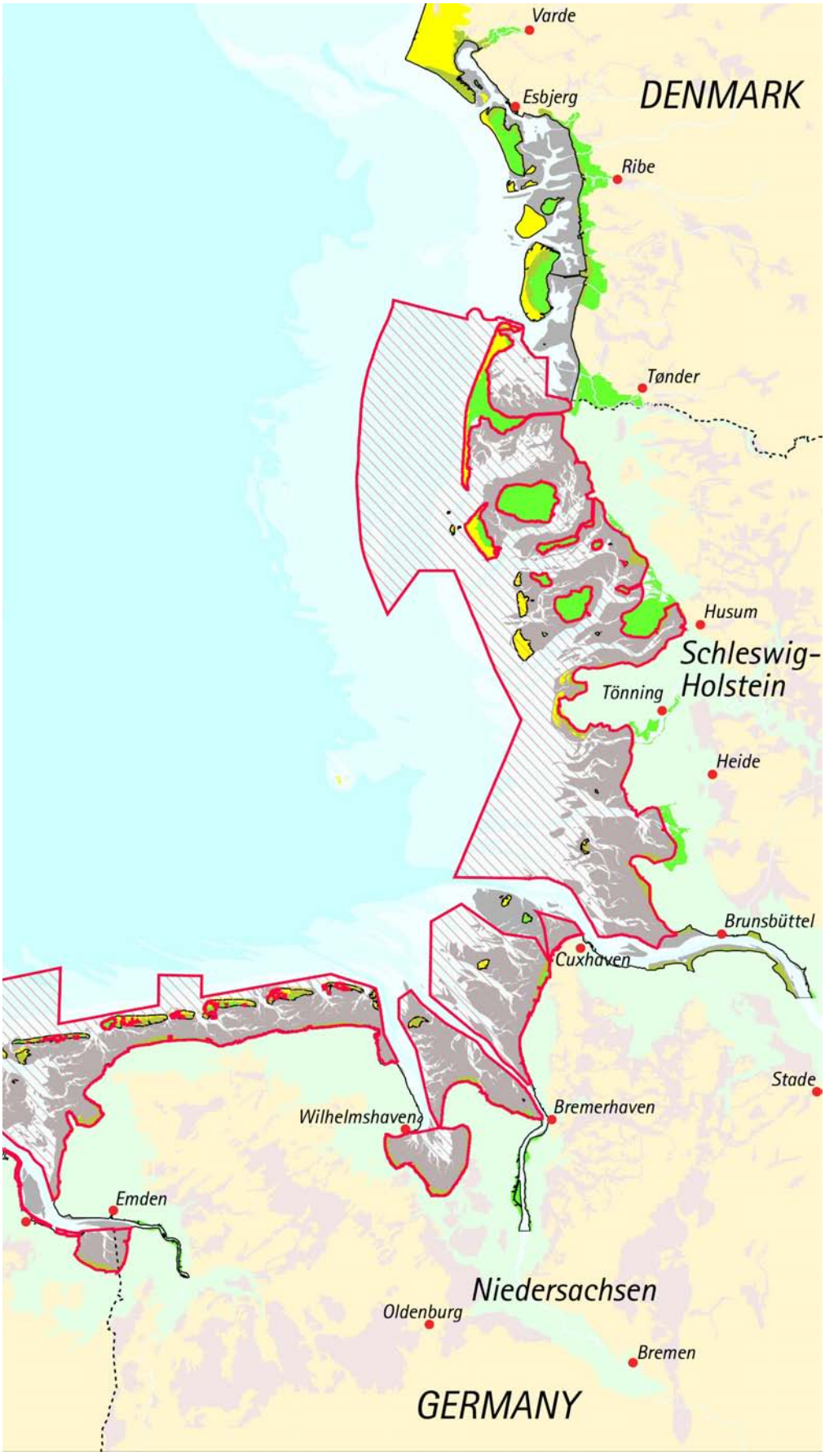


Figure 1.4:
The Wadden Sea and the nominated property.


Varde
Esbjerg
DENMARK
Ribe
Tønder
Husum
Schleswig-
Holstein
Tönning
Heide
Brunsbüttel
Cuxhaven
Stade
Wilhelmshaven
Bremerhaven
Emden
Niedersachsen
Oldenburg
Bremen
GERMANY

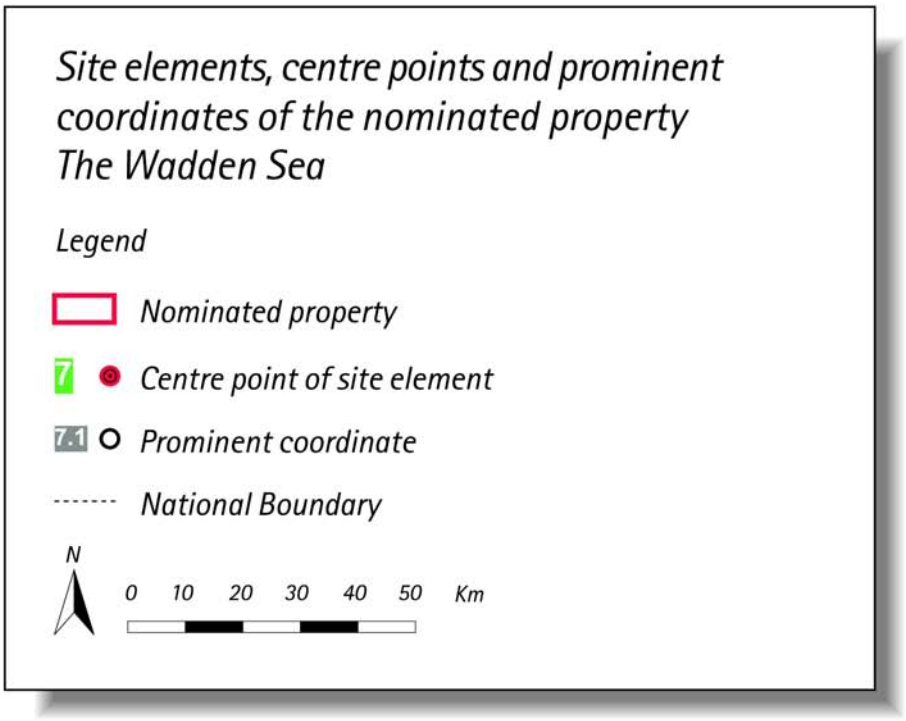


Figure 1.5:
Different site elements of the nominated property.

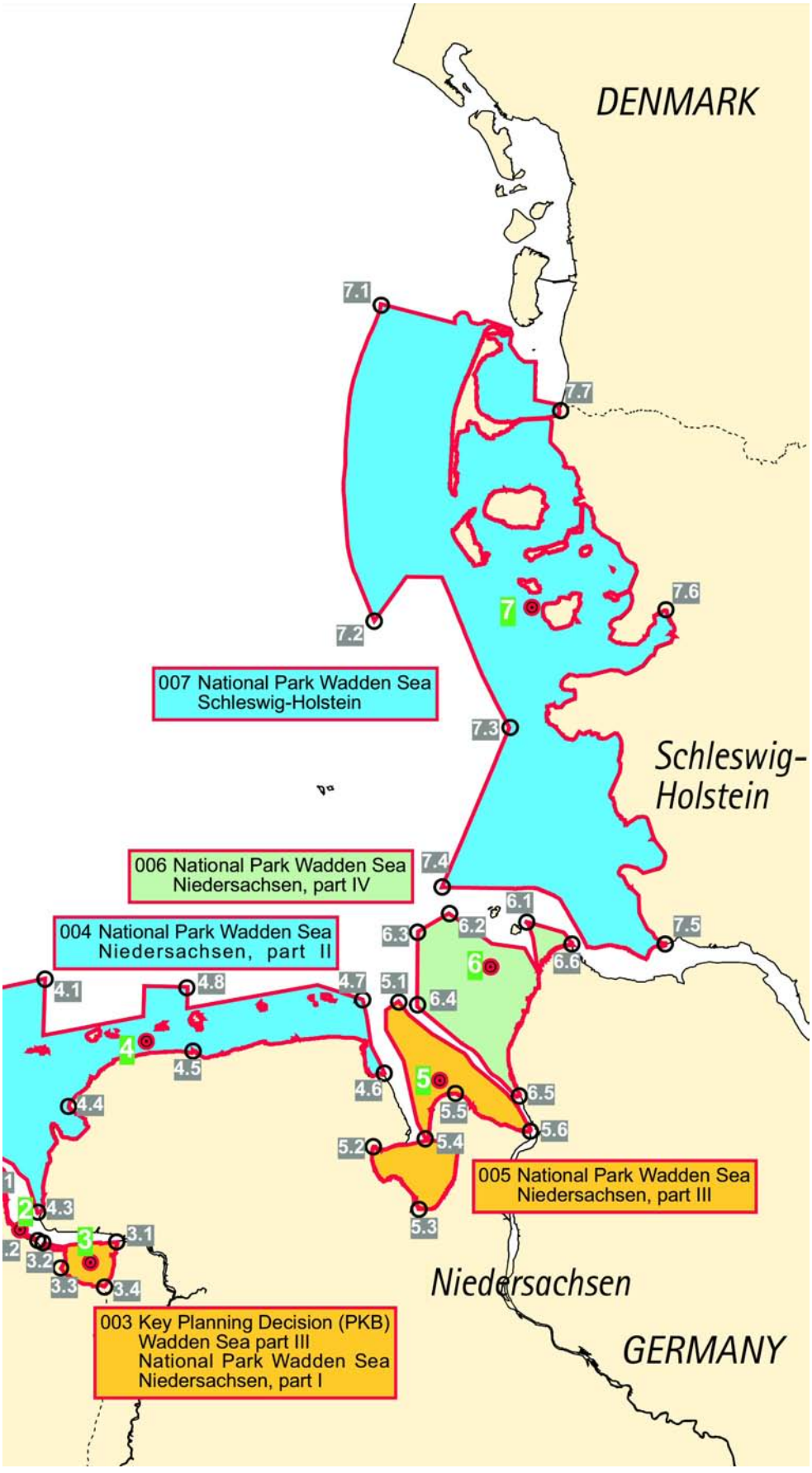
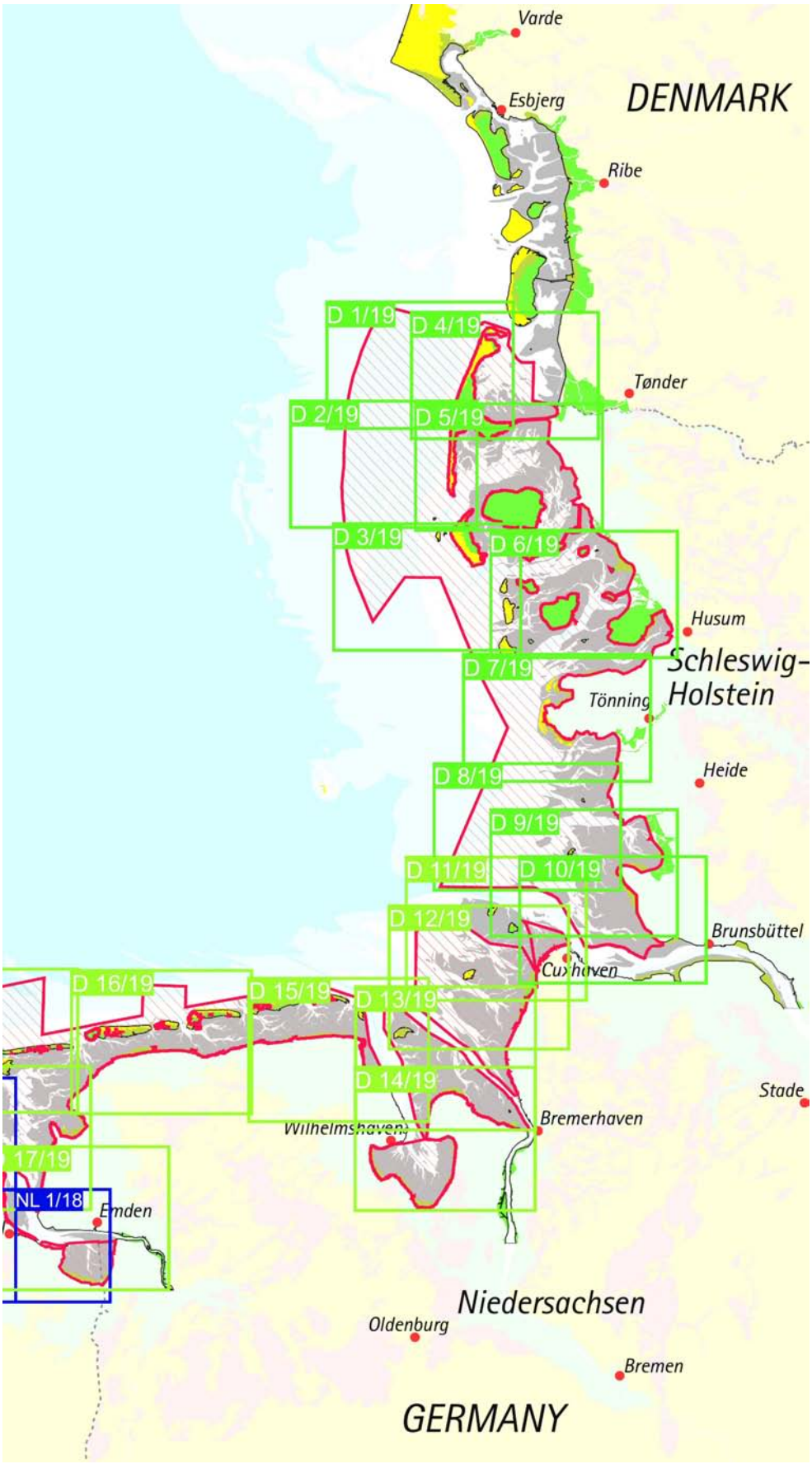

DENMARK
007 National Park Wadden Sea Schleswig-Holstein
Schleswig-Holstein
006 National Park Wadden Sea Niedersachsen, part IV
004 National Park Wadden Sea Niedersachsen, part II
005 National Park Wadden Sea Niedersachsen, part III
003 Key Planning Decision (PKB) Wadden Sea part III National Park Wadden Sea Niedersachsen, part I
Niedersachsen
GERMANY

Figure 1.6:
Distribution of the topographic maps for the nominated property.


Varde
Esbjerg
DENMARK
Ribe
D 1/19
D 4/19
Tønder
D 2/19
D 5/19
D 3/19
D 6/19
Husum
Schleswig-
Holstein
D 7/19
Tönning
Heide
D 8/19
D 9/19
D 11/19
D 10/19
D 12/19
Brunsbüttel
Cuxhaven
D 16/19
D 15/19
D 13/19
D 14/19
Stade
Wilhelmshaven
Bremerhaven
17/19
NL 1/18
Emden
Niedersachsen
Oldenburg
Bremen
GERMANY

the strictest protection are e.g. the main haul-out sites for harbour and grey seals and high water roosts and breeding sites for birds. These areas are closed for access the whole or part of the year. Outside these strictly protected areas, admission and use of the area is allowed, basically on the condition that these activities do not adversely affect the area and its ecological and landscape values. In addition, several activities are regulated in time and space, such as areas where mussel fishery is prohibited.

The Wadden Sea Plan, as outlined in chapter 5.e, is valid for the Trilateral Wadden Sea Cooperation Area, in short the Wadden Sea Area. The Wadden Sea Area includes the nominated property and is delimited by 3 nautical miles offshore, with the exception of areas off the East Friesian islands and off the islands of Sylt and Amrum, where the delimitation goes beyond the 3 nautical miles up to 12 nautical miles, the seawalls of the mainland or - where the main dike is absent - the spring high tide water line, the brackish water limits of the rivers Ems, Weser and Elbe and inland Ramsar and NATURA 2000 areas.

The purpose of the buffer zone according to paragraph 104 of the Operational Guidelines is to provide an extra layer of protection to the property. The size of the nominated property, the scope and span of the regulations in place and international agreements and regulations, both in space and scope, ensure the integrity of the nominated property and fully meet the intent of paragraph 104 of the Operational Guidelines. The EC Habitats Directive stipulates e.g. that any plan or project, either within or outside of the nominated property, likely to have a significant effect on it shall be subject to appropriate assessment of its implications for the site. Therefore, a buffer zone to the nominated property has not and will not be designated.

1.f Area of nominated property

The nominated property "The Wadden Sea" encompasses the Dutch Wadden Sea Key Planning Decision Area, the Niedersachsen Wadden Sea National Park and the Schleswig-Holstein Wadden Sea National Park.

The nominated property does not include the Danish part of the Wadden Sea Conservation. The Danish part of the Conservation Area is 1,250 km2 which amounts to 12.7% of the total Wadden Sea Conservation Area.

In 2000-2001 the regional consultations on the nomination of the Danish part of the Wadden Sea Conservation Area for inscription in the World Heritage List took place in preparation of the 9th Wadden Sea Conference in Esbjerg on 31 October 2001. The result was that the adjacent county councils voted against a nomination. It was therefore agreed within the Trilateral Wadden Sea Cooperation at the 2001 Wadden Sea Conference to await the finalization of the consultations in all parts of the Wadden Sea Region. In 2003, the Danish Wadden Sea was chosen, as one of seven national pilot projects, for the exploration of the possibilities for establishing national parks in Denmark. The deliberations as to designating the Danish part of the Wadden Sea Conservation Area or an extended area as a national park have not yet been concluded, and further consultations on the World Heritage nomination have not been initiated pending the passing of legislation in the Danish parliament and the decision on whether to designate the Danish Wadden Sea as a national park.

It is to be acknowledged that the Danish part of the area is 12.7% of the total Wadden Sea Conservation Area, as indicated above. All typical features of the Wadden Sea ecosystem are repre-

Table 1.3: Size and distribution of the nominated property.

Site Element	Name	Size in Hectare	Size in km²
001	Key Planning Decision (PKB) Wadden Sea, part I	248,883	2,488.8
002	Key Planning Decision (PKB) Wadden Sea, part II	779	7.8
003	Key Planning Decision (PKB) Wadden Sea, part III / National Park Wadden Sea Niedersachsen, part I	8,875	88.8
004	National Park Wadden Sea Niedersachsen, part II	166,650	1,666.5
005	National Park Wadden Sea Niedersachsen, part III	49,134	491.3
006	National Park Wadden Sea Niedersachsen, part IV	59,627	596.3
007	National Park Wadden Sea Schleswig-Holstein	439,614	4,396.1
	Total Property	**973,562**	**9,735.6**

sented within the nominated property. Moreover, Denmark remains a partner within the trilateral Wadden Sea cooperation and has signed up to the Wadden Sea Plan, which provides for the same level of protection and regulation of the Danish part of the Wadden Sea as for the nominated property.

Furthermore, the small Hamburg Wadden Sea National Park of 136 km² is not included in the nominated property. The state government of Hamburg decided to postpone the nomination of its part pending the decision on the deepening of the Elbe shipping lane in conjunction with an environmental impact assessment study. As outlined in chapter 4, the project is located outside the nominated property and the Hamburg National Park.

Taking account the extensive preparations already undertaken, the increased public support for the nomination in both countries and the uncertainty of whether and when further consultations on the World Heritage nomination will be re-initiated in the Danish Wadden Sea region, Germany and the Netherlands have decided to proceed with the Dutch-German nomination. This decision was made at the 10th Governmental Danish-German-Dutch Wadden Sea Conference on 3 November 2005 on the Dutch Wadden Sea island of Schiermonnikoog.

Tidal flat creeks in the Wadden Sea at sunrise (Photo: Martin Stock).

System of tidal gullies in the Wadden Sea (Photo: Martin Stock).

2. DESCRIPTION

2.a Description of the property

The Wadden Sea is a coastal wetland of exceptional size, great beauty and richness in unique natural assets. It is one of the largest coastal wetlands in the world. Coastal wetlands are products of a post-glacial sea level rise by more than one hundred meters. These transitional zones between sea and land have been continuously shifting in size, shape and position over the last 16,000 years and will continue to do so. Although, in structure and function these wetlands resemble those of ancient coasts, they are in fact rather recent and highly dynamic features of the earth system. For this reason, existing coastal wetlands are not cradles of endemic organisms or refugees for relicts of the past.

Their biota has a long evolutionary history of adaptations to coastal dynamics, frequent natural cataclysms and to the environmental extremes of the coastal zone. The physical environment of coastal wetlands is a great challenge to life. Favoured are either versatile organisms or specialists with a wide dispersal. The latter is necessary in order to balance between frequent disappearances and new emergences elsewhere of their specific coastal habitat type. The net result of this evolutionary history is a rather small set of the world's species that can thrive in coastal wetlands. However, those which can are of a very special kind.

On the other hand, the outstanding plenitude of resources in coastal wetlands has given rise to an extraordinary biotic production. Via migrating and drifting organisms there is even an outreach far beyond the confines of the wetlands proper. The Wadden Sea is an indispensable hub along the East Atlantic flyway of coastal birds between northern and southern hemispheres. Its shallow waters are a nursery for finfish and various invertebrates of the entire coastal sea and even beyond.

The richness and exceptional productivity of the biota in coastal wetlands has attracted people from early on, in spite of the environmental hostility. With advancing technology, more and more of these wetlands have been separated from the sea and transformed into dry land. Also, the Wadden Sea has been to some extent subject to attempts at coastal conversion. However, it still has maintained the largest coherent area in the world with marine tidal sediments. These appear to be drenched land when the tide is out and a shallow sea when the tide is in. The Wadden Sea is a coastal sea shallow enough to wade across. The unique character and the outstanding vastness of these tidal flats with fringing salt

Figure 2.1:
Northeast Atlantic with the North Sea region.

marshes, beaches, dune islands and shoals and the spectacular abundance of wildlife is motivation for this proposal to have it designated as World Heritage Site.

Almost three decades ago, scientists of the Netherlands, Germany and Denmark provided a comprehensive review of existing knowledge on natural processes and human impacts in the Wadden Sea[1]. This has provided a firm basis for environmental policies and management. The state of knowledge has been updated about every three years in proceedings of scientific symposia on the Wadden Sea environment[2]. The ecological quality status has been regularly assessed in reports since 1991 based mainly on the results of the Trilateral Monitoring and Assessment Program (TMAP) referred to in chapter 6[3]. Together with workshops on selected topics such as sustainable coastal protection, salt marshes or trends in bird populations, this strong scientific dedication to the Wadden Sea provides a broad and solid basis for the following description.

1_____Wolff WJ (ed) 1983 Ecology of the Wadden Sea. Balkema, Rotterdam, The Netherlands.

2_____Wolff WJ 2003 Ten international scientific Wadden Sea symposia in 25 years: what did we achieve? In: Wolff WJ et al (eds) Challenges to the Wadden Sea. Univ. Groningen, NL: 27-30.

3_____Essink K et al. (eds) 2005 Wadden Sea Quality Status Report 2004. Wadden Sea Ecosystem No.19. Common Wadden Sea Secretariat, Wilhelmshaven, Germany.

In this chapter, the "Wadden Sea" refers both to the nominated property as well as to the ecosystem in the broadest sense. In a few cases, it is necessary in the description of the geomorphology, hydrodynamics and habitats to make digressions beyond the confines of the nominated property, because natural processes and, in particular, migratory organisms do not respect administrative boundaries.

The Wadden Sea contains the largest coherent tidal flat area in the world. It is spread out along the southern edge of a stormy shelf sea. From the land side, large rivers enter, which drain a continental area of the cold and moist temperate climatic zone in the northern hemisphere. This coastal transition is extremely flat, with its deepest and highest parts all within 50 m below and above mean sea level. The Wadden Sea was formed after a rapid post-glacial transgression and has remained highly dynamic in size and shape due to changes in sea level, tides, waves and strong winds. It consists of a dynamic mosaic of habitats with fringing brackish and marine marshes, estuarine and open coastal tidal flats, beaches, dunes, sand bars and barrier islands, tidal streams, inshore shallows and offshore waters. These together sustain a specific and diverse coastal flora and fauna.

The Wadden Sea is a gigantic coastal filter and an ecological focal point for biotic production and migrant animals. People have been living in the

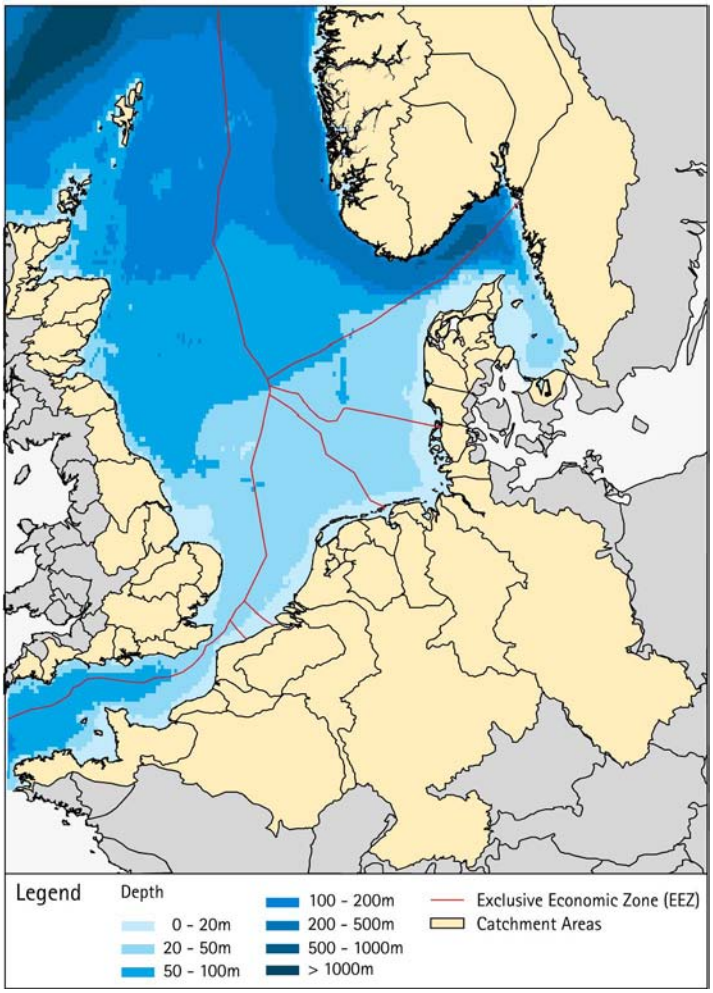


Figure 2.2: Bottom topography and catchment areas of the Greater North Sea (Source: OSPAR Commission).

Wadden Sea area from the very beginning of this amphibious and dynamic landscape. Early settlers in the marshes built knolls (*Terpen, Wierden, Wurten, Warften*) to live upon. In a later phase, they claimed land by separating marshes from the sea with earthen walls (*dikes*). They affected flora and fauna by habitat transformations, the extraction of materials, and by hunting and fishing. However, the unique coastal landscape and seascape still resemble very much intact conditions, and the extraordinary flocks of coastal birds and the abundant seals are indicative of a thriving coastal ecosystem.

Physical environment

The nominated property is an extremely shallow and elongated coastal margin, without a clear boundary between land and sea. Land lies in water and the sea moves over land. This land has been formed by the sea, and this sea is in perpetual tidal motion and at times stirred up by violent storms. The coastal climate is mainly determined by oceanic forces.

Geography

The northern oceans of the world are fringed by extensive shelf seas. On the Atlantic shelf of Western Europe, the North Sea is with 520,000 km² the largest shelf area (Fig. 2.1). To the west, it is connected with the Atlantic shelf through the English Channel and shielded from the North Atlantic basin by the British Isles. To the east, the Skagerrak connects it with the enclosed Baltic Sea. To the north, there is a wide transition to the deep Norwegian Sea. In the south, the North Sea meets the European continent, and here the shallow Wadden Sea comprises most of the coastline. It is linked to the ocean but located in the innermost part of one of its marginal seas.

The North Sea shelf area is an ancient continental drift depression, overlain by sedimentary deposits several kilometres thick. These originated from the surrounding land masses, and some of their strata contain large amounts of liquid and gaseous hydrocarbons, which are intensively exploited. The depth of the North Sea increases

Table 2.1: Geomorphological region of the Wadden Sea Area with major subdivisions of the land- and seascape transition (km²).

Geomorphological region	Area (km²)
Salt marshes	400
Intertidal sand and mud flats	4,700
Subtidal flats and gullies	3,700
Islands and dry sandy shoals	1,000
Offshore area (to about –15 m depth-line seaward of the islands)	4,900
Total Wadden Sea Area	**14,700**

towards the Atlantic Ocean to about 200 m at the edge of the continental shelf. In the middle of the North Sea lies the shallow area of the Dogger Bank, where depths can be less than 20 m. This bank has a significant impact on the circulation in the southern North Sea and is an important fishing area.

The southern half of the North Sea is very shallow, mostly less than 50 m in depth, and here several large rivers debouch: Humber, Thames, Schelde, Maas, Rhine, Ems, Weser and Elbe (Figure 2.2). These rivers cause oceanic salinity to be slightly depressed in the coastal waters and nutrient concentrations to be elevated. Many of these rivers developed inner deltas and outer estuarine funnels with extensive freshwater and brackish marshes which merge at the outer coast with salt marshes of marine origin.

The shallow southern North Sea meets an extremely flat marshland, only occasionally intersected by moderate elevations of glacial origin or of dunes on barrier islands. These elevations generally remain below 50 m in height. In the tidal inlets with strong scouring currents the depth rarely exceeds 50 m. Thus, over a length of 1000 km of coastline and an average width of 250 km, the profile remains within the narrow vertical confines of about 100 m. The central part of this coastal flatland and shallow sea has been named the Wadden Sea because here tidal flats – where one may wade through – show their widest extent.

As a seaward limit of the Wadden Sea the -15 m depth contour has been suggested which is parallel to but usually somewhat beyond the administrative boundary of the Wadden Sea. Selecting this depth contour is somewhat arbitrary anyway, but refers roughly to the boundary of an assumed coastal sediment exchange system, and coincides also with the seaward occurrence of some important seasonally migrating aquatic organisms of the tidal area. Coastal birds extend their feeding ranges rarely further offshore. Also, the landward limit of the Wadden Sea depends somewhat on the aspects in mind. Geomorphologically all the flat marshlands are included up to a maximum of 5 m above mean sea level. This is roughly equivalent to the widest transgression of the sea in the distant past and subsequent deposition of marine and fluvial sediments.

The long shore extent of the present Wadden Sea reaches to the Skallingen peninsula in Denmark and the Den Helder peninsula in the Netherlands. The coastline distance between these is roughly 500 km. The geomorphological width between seaward and landward boundaries may be up to 150 km in the estuaries but the average is only half of that. The Wadden Sea Area with its offshore parts is about 14,700 km², which comprises a maritime zone from flat land to shallow waters (Table 2.1).

The tidal area is smaller. The long shore limits are the same, but the seaward boundary is defined as the line connecting all barrier islands and sand bars, and the landward boundary is the dike line or, in a few cases, Pleistocene cliffs beyond which the sea does not extend. This area is about 8,400 km², and of this, intertidal sediment flats comprise nearly half of the area.

This area of the Wadden Sea may be divided into three sub-regions:

- The *Southern Wadden Sea* extends from the Marsdiep tidal inlet in the west to the Jade inlet in the east. Twelve main islands form a seaward sandy barrier some 5 to 15 km off the mainland coastline and provide shelter to the tidal area against waves generated by northwestern and northern winds. A large embayment, the former brackish Zuiderzee (3,600 km²), was once part of the Southern Wadden Sea but became separated by a causeway in 1932 and was turned into a freshwater lake and agricultural land. Another embayment, the Dollard in the Ems estuary, still exists.
- The *Central Wadden Sea* extends from the Jade inlet to the Eiderstedt peninsula, and has three major estuaries: Weser, Elbe and Eider. Across the Eider estuary a storm surge barrier has been built. Salinity is lower and more variable in the central sub-region than in the others, while tidal range is higher. A seaward chain of barrier islands is absent. With the Jadebusen a large embayment extends deep into the marshland.

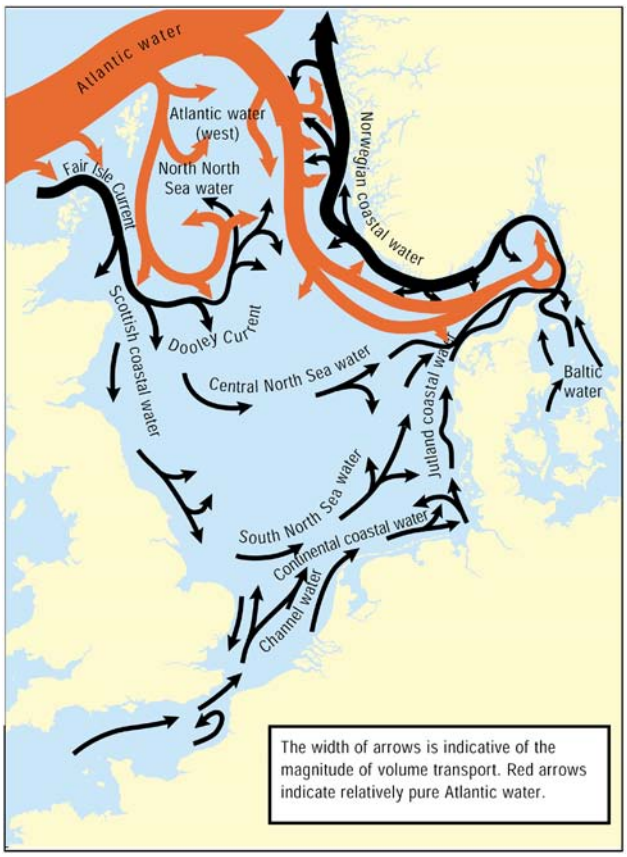


Figure 2.3: Schematic diagram of general circulation in the North Sea (Source: OSPAR Commission).

- The *Northern Wadden Sea* extends from the Eiderstedt peninsula in the south to the Skallingen peninsula in the north. Eight islands and high sand bars form a seaward barrier some 5 to 25 km off the mainland coastline, and provide shelter against waves generated by the prevailing westerly winds. Several marsh islands are scattered across the tidal area and are remnants of a coherent marshland which became drowned in medieval times. Only here also some Pleistocene cliffs occur. Large estuaries are absent.

Hydrology

A key feature of the hydrology of the southern shores of the North Sea is a continuous long-shore current from southwest to northeast (Fig. 2.3). It is supplied with Atlantic water passing southward along the British east coast and eastward through the English Channel. These water masses merge west of the Wadden Sea, then continue as continental coastal currents following the coastline just seaward of the tidal area and finally adding to the Norwegian Trench outflow back into the Atlantic. This coastal long-shore current takes up the river runoff of the Rhine and Elbe together with several smaller rivers. It is this mixed water body, which supplies the tidal area of the Wadden Sea and which is hydrologically a coherent part of the coastal long-shore current.

All rivers discharging directly into the waters of the Wadden Sea come from a catchment area of 230,000 km² with an annual discharge volume of 60 km³. Together with the Rhine and a few other rivers debouching adjacent to the Wadden Sea and affecting its waters, catchment area and freshwater discharge approximately double. These rivers cause fluctuations in salinity. Usually, slightly lower average values occur in winter and spring and higher values in summer. This reflects the precipitation pattern of north-western Europe. However, the riverine influence is not strong enough to categorize the entire Wadden Sea as an enlarged estuary. It is not an open oceanic coast either. The Wadden Sea holds a hydrologically unique intermediate position with three major hydrological characteristics:

- Salinity remains mostly between 20 to 30 psu, which is lower than oceanic waters (34) but higher and less variable than in most estuaries (0-20);
- Wave exposure is mitigated by a barrier of sandy islands, sand bars and shoals, while

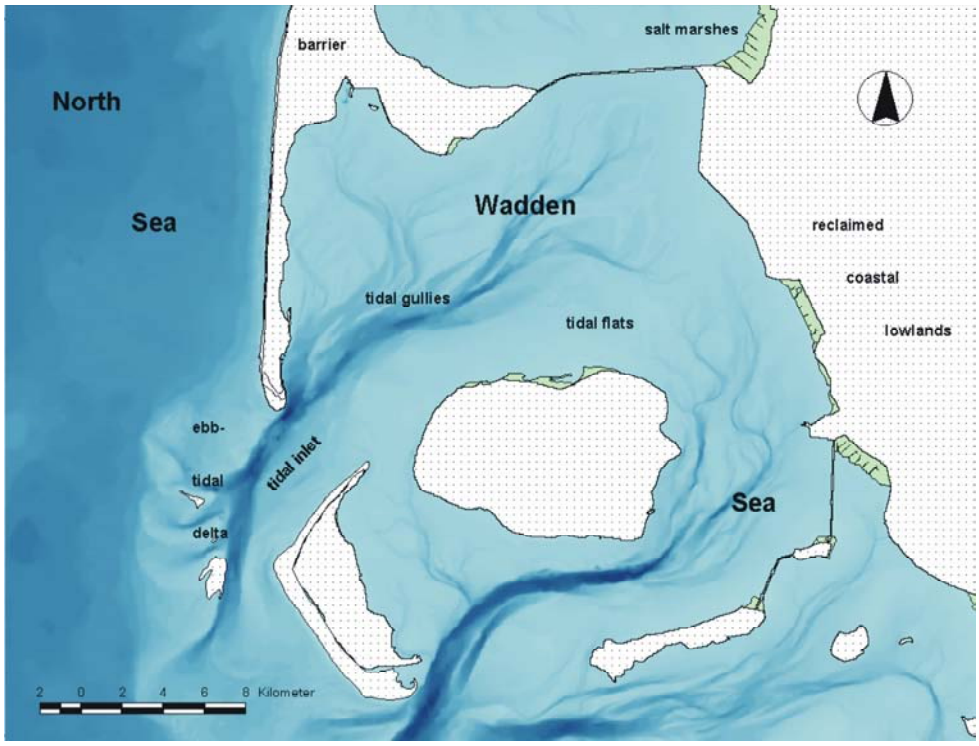


Figure 2.4: Geomorphological elements of the Wadden Sea coast (J. Hofstede; source: Wadden Sea Ecosystem No. 21).

tides and frequent storms keep the waters in perpetual motion;

- Meso- to macrotidal (1.4 to 4.0 m mean tidal range) conditions in combination with an extremely gentle slope from land to sea expose the bottom of the sea over an average width of 15 km (range 5 to 25) and an area of 4000 km².

A further distinctive hydrological feature of the Wadden Sea is the continuous series of tidal basins which are analogues to riverine catchment areas. However, they differ from these by having alternating flow directions with the tides (Fig. 2.4).The existence of tidal basins is interrelated with the existence of barrier islands or high sands. Between adjacent islands, the tidal flow is compressed, forming tidal inlets up to 50 m in depth, scoured by strong currents. Behind the barrier islands most inlets furcate into major gullies (channels) and these branch into smaller and smaller tidal creeks or runnels in a recurrent fractal pattern. In the back-barrier area, flood waters of adjacent tidal inlets meet at tidal divides (watersheds). Seaward of tidal inlets, ebb deltas form with highly turbulent waters. Here ebb currents interfere with waves and the long-shore current. As a result, transported sand accumulates in the form of highly dynamic bars and shoals.

Altogether, a series of 33 such tidal inlets with their back-barrier basins and ebb deltas have been identified as recurrent features of the hydrography of the Wadden Sea. They are connected by some overflow across tidal divides in the back-barrier area and by the tidal flow and long-shore current seaward of the islands. Because of their lateral connections across watersheds, these tidal basins are different from coastal lagoons, which are a common feature of many other shores in the world. The regular pattern of tidal basins is interrupted by four major estuaries: Ems, Weser, Elbe and Eider. Their riverine runoffs add up with the ebb flow. The resulting strong currents tend to displace ebb deltas by wide open funnels. These estuaries provide habitats of highly fluctuating and low salinities, in rare cases even freshwater tidal areas.

Tides are semi-diurnal (two ebb and two flood phases per day). Mean vertical ranges increase from 1.4 m in the southwest to almost 4 m in the Central Wadden Sea and decrease from there again to 1.5 m in the north. Twice a day tides move an average volume of 15 km³ of sea water into the tidal back-barrier area, where roughly the same volume remains in the subtidal zone, thus swelling up to some 30 km³ at high tide. This high exchange rate of tidal water masses secures the dominance of marine conditions in the back-barrier area. Tidal waves progress counter-clockwise within six hours through the Wadden Sea: when the tide is high in the southwest, then it is low in the northeast.

Figure 2.5:
Mosaic of satellite images of the period 2000–2002 (Source: Eurimage, Common Wadden Sea Secretariat & Brockmann Consult).

Consequently, a single aerial image cannot show the full extent of tidal exposure. To show this, several images need to be combined.

The effects of full and new moon phases on tidal range is only about 20% in the Wadden Sea. Instead, strong onshore winds may increase high tides up to 4 m above normal high tide levels. Strong offshore winds may push low tides down to 1.5 m below normal low tide level. Corresponding to this asymmetry in modifying tidal heights, also the frequency of strong onshore winds is much higher than of strong offshore winds. Thus, tidal flats may often remain submerged over several days due to prevailing strong westerly winds, while continuous emergence over several tidal cycles caused by southern or eastern winds is rare. Because of this, it is easier for marine than for terrestrial organisms to persist in the tidal zone of the Wadden Sea.

Climate

With a latitude of 53° to 55° N, the Wadden Sea climate would resemble that of Hudson Bay, the Bering Sea or the Sea of Okhotsk in Siberia, if it were not for the warm water masses of the Gulf Stream that pass north-western Europe and also penetrate into the North Sea. Climatically, the Wadden Sea region is more akin to the Gulf of Maine, Vancouver Island, the Sea of Japan or the Yellow Sea, all between 40° and 50° N. The climatic conditions are characterized by the interaction of humid maritime air masses coming from westerly directions, and dry continental air masses coming from the east. The eastward moving depressions originating in the North Atlantic dominate with their westerly winds. This explains rather mild

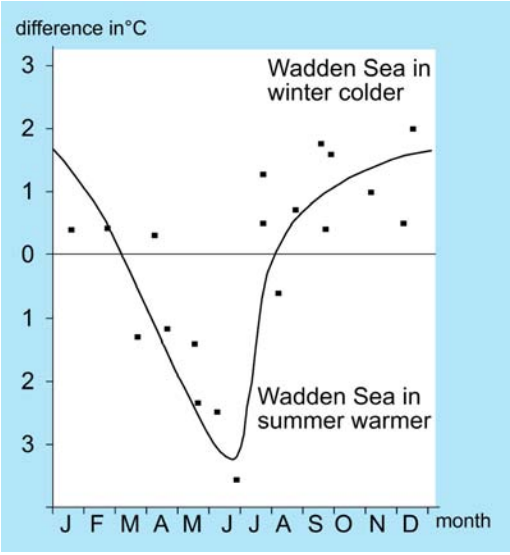


Figure 2.6:
Seasonal development of water temperature in the Wadden Sea and North Sea (modified from: Het beheer van de Wadden 1985).

Megaripples on tidal flats (Photo: Martin Stock).

winters and cool summers. The mean annual air temperature is around 8.5°C. The mean annual water temperature is about 9°C, with a summer average of 15°C and a winter average of 4°C. Extreme water temperatures of the last six decades were +23°C and -2.3°C in the tidal area.

In the tidal area, at least some ice cover was observed on an average of 19 days per year in the last century. The tides prevent the development of a coherent ice sheet. They break it up and ice floes become piled upon each other, drifting to and fro, and being dragged across tidal flats, leaving trails and pits behind. Sediments in the high tidal zone may become frozen to a depth of a few centimetres. In recent times, however, winters with ice and frozen sediments in the Wadden Sea have become rare.

In summer, the regular tidal exchange of water masses rarely allows water temperature to exceed 20°C, although in residual waters on the tidal flats up to 32°C have been measured on sunny days. Important for many organisms is a seasonal reversal of temperature between the tidal area and offshore coastal waters (Fig. 2.6). The latter are colder in summer than the water above the tidal flats, while offshore waters remain warmer during winter than those further inshore. Particularly in spring, the early warming up of the shallow tidal waters facilitates reproduction and growth of tidal zone organisms. Conversely, cold spells in early winter initiate migrations from inshore to offshore.

In spite of humid air from the sea, precipitation in the Wadden Sea region is moderate, with some 700 to 800 mm per year or roughly 2 mm per day. Clouds often pass the Wadden Sea, and rain comes down further inland where the terrain reaches higher elevations. Rainwater has little direct effects on the salinity in the tidal area. Indirect effects by river runoff are stronger.

Of great importance for climate variation in the Wadden Sea are the North Atlantic oscillations between low air pressure in the north (Iceland) and high pressure in the south (Azores). This gradient in air pressure tends to be pronounced and is associated with strong westerly winds, cool summers and mild winters at the North Sea coast. However, this pressure gradient has shown an approximately decadal periodicity in the past. Periods with a steep pressure gradient and thus frequent storm surges, wet and mild winters alternate with periods of a weak gradient and thus continental climate with easterly winds and severe winters. These periodicities have been shown to affect abundances of marine organisms and migrations of birds.

The overall effect is a rather variable temperate climate. Moderate maritime conditions prevail and continental extremes are rare. Climate change scenarios predict the maritime dominance in winter to become even stronger, while summers may be subject to more continental influence. Thus, storminess and rain in winter may increase while freezing conditions may become exceedingly rare. Warming in spring may commence earlier and waters will attain higher temperatures in summer

which then last longer in autumn. Sea level rise is expected to lag behind atmospheric warming but will eventually have more serious consequences for the shallow and flat Wadden Sea. With more than half a meter of sea level rise by the end of this century, the size of the tidal flats could decrease by 15% and the tidal basins will take the character of tidal lagoons if no mitigation measures are taken.

Geology

The Wadden Sea is a sedimentary region. Tectonic activities do not threaten this coast. Neither vulcanic eruptions nor serious earthquakes are expected. Since the Tertiary, the region has been part of a descending basin, gradually filling up with Quarternary sediment of 1000 m thickness or even more. This pattern is only sporadically interrupted by uplifting domes of Permian salt. This phenomenon has given rise to a Triassic outcrop adjacent to the Wadden Sea, the rocky island of Helgoland. Similarly, on Sylt, one of the northern islands in the Wadden Sea, Tertiary layers have been lifted upwards.

Otherwise, the entire region of the Wadden Sea is composed of residues of the Quarternary glacial periods. Scandinavian glaciers have modulated and transported a variety of materials with origins spanning almost the entire history of the earth and deposited these mixed sands and stones in the Wadden Sea. Glaciers have passed over several times, carved valleys and left moraines as hills in the landscape, sometimes with large bolders grinded by ice. Also, riverine sediments from Scandinavia have become deposited in the area.

The current landscape and submarine seascape is almost a complete product of the last three glaciation periods and their interglacial phases, including the present one. Presumably, the past interglacials have given rise to coastal environments similar to the present Wadden Sea. At least fossils indicate a marine fauna similar to the present one, and ancient cliffs and marine sediments show how far past interglacial seas have transgressed into the land.

The glacial front of the last glaciation, with its maximum 18,000 years ago, stopped just eastward of the present region of the Wadden Sea, which presumably was covered by tundra vegetation throughout that time. Sea level was down to 120 m below what it is now. With the onset of warming, sea level has risen rather fast and reached the present region of the Wadden Sea about 8,000 years ago. Then sea level rise began to slow down and the geomorphology of the Wadden Sea started to evolve.

Morphodynamics

The characteristic geomorphology of the Wadden Sea with mainland marshes, extensive tidal flats and a long chain of barrier islands developed gradually over the last 8,000 years and is still in motion. Its unique geomorphology is the product of a combination of five major past and ongoing processes: (1) Glaciations left a smooth relief of gentle valleys and hills where rivers found their course and which determined the general shape with a bend in the coastline at the mouth of the Elbe river from west-east to south-north in direction. (2) Post-glacial sea level rise entailed a progressively growing tidal range and gradually enlarged the tidal area. (3) The southern North Sea basin supplied sediments to the region of the Wadden Sea, transported by long-shore currents, tides and waves. (4) Strong onshore winds have caused episodic floods of up to 4 m above normal high tides. These floods left conspicuous and lasting effects on the landscape. Strong onshore winds have also given rise to massive dunes on the barrier islands. (5) Large rivers which debouch near to or directly into the Wadden Sea have added fine sediments to the coast.

Together, these processes have created a dynamic and amphibious coastal land- and sea-scape with an extent of tidal flats which is nowhere else to be found in the world. In the last millennium the episodically flooded higher part of this coastal landscape became more and more transformed by human activities, while the tidal area remained very much the product of a natural interplay between a shallow sea and a flat land.

The valleys and trenches formed by the glaciers affected the course of the rivers Ijssel, Ems, Weser, Elbe and Eider and the positions of the conspicuous estuaries. Glacial moraines form the core of the islands Texel, Föhr, Amrum and Sylt. Presumably there were some glacial relict islands seaward of the present Wadden Sea. Their erosion in the course of sea level rise probably served as an important source of sediment. Landward of the marshes, gentle moraines dominate the landscape. As remnants of past transgressions, some show former cliffs which provide magnificent platforms to view the marshes, the tidal area and islands.

Changes in sea level have been most influential and will continue to be so. It is assumed that when post-glacial sea level rise slowed down 8,000 years ago, a seaward barrier of sand bars and long spits developed. Between this barrier and the glacial moraines, a back-barrier area of lagoons and marshes came into existence. At the feet of moraines, raised bogs developed. Alongside

rivers, gallery forests grew up, while otherwise the landscape remained without trees because of episodic flooding by the sea.

With increasing tidal range, the outer sandy barrier broke up into a chain of barrier islands. Concomitantly, the tidal area grew larger at the expense of marshes. Sequences of preserved sediment layers indicate that the balance between marshes and tidal flats shifted back and forth as a result of variable sea level and sediment supply. The overall trend, however, was a rise in sea level. The chain of barrier islands gradually moved landwards and tidal inlets adjusted their cross sections to changing volumes of tidal waters. These dynamics are still ongoing and are expected to accelerate with more rapid sea level rise in the wake of global warming.

Long barrier spits are common at depositional coasts. They occur where average tidal ranges are less than 1.5 m. This is the case adjacent to the Wadden Sea along the Dutch coast and in northern Jutland. The peculiar chains of barrier islands in the southern and northern Wadden Sea are the consequence of tidal ranges between 1.5 to 3 m. Above 3 m no barrier systems persist. Maximum tidal current velocities in tidal inlets reach about 1.5 ms^{-1} at spring tides. These currents are sufficient to keep channels open in spite of sediment supply. In the Central Wadden Sea, major rivers debouch and tidal ranges tend to be higher than 3 m. Therefore the central part lacks barrier islands. Only small ephemeral islands do occur around mean sea level, surrounded by extensive tidal flats.

As remnants of formerly more extensive marshes, some marshy islands are interspersed in the tidal back-barrier area in the Northern Wadden Sea. Altogether there are at present some fifty islands and high sand bars, some of which are episodically flooded during storm surges. Marshy islands flooded during storm surges are called *Halligen*. Their vegetation consists of salt marshes and they grow upwards layer by layer when new deposits are added during flooding. Often the surrounding tidal flats do not grow up at the same pace. Then edge instabilities arise and the *Halligen* become eroded or have been protected by brushwood groins or stonewalls in response. Houses on *Halligen* have been built on mounds. They are the only parts which remain above the water during storm tides. These *Halligen* with their dwelling mounds are a unique feature of the northern Wadden Sea and find no parallel elsewhere in the world.

Through the tidal inlets, sediments are moved from the outer coast into the tidal area and back again. The balance of this sand-sharing system varies with shape and size of tidal basins. Large back-barrier tidal basins have extensive ebbtidal deltas and deep tidal inlets. Usually less than half of the basin area is occupied by tidal flats. Small basins have small ebb deltas, shallow inlets and the share of intertidal flats is more than half of the area.

These hydrological and geomorphological relations are highly sensitive to sea level and variations in storminess. Accordingly, the geomorphology remains very dynamic. Small islands emerge and others disappear in the course of the centuries such as the islands Bosch in the Dutch part and Buise in the German part of the Wadden Sea. This phenomenon is accessible to experience within human life spans. There is little local stability but a high resilience of the general coastal configuration, which has persisted through the last millennia. However, there never was and still is no morphological equilibrium. Permanent change is the consequence of trends in sea level, tidal range and climate.

A shallow sea and a flat land also meet at other coasts of the world; however, the Wadden Sea has developed a unique geomorphology with its specific combination of physical factors and their interactions with the regional biota. This will be further detailed in the following paragraph and in the chapter on habitats.

Soils and sediments

Natural rock formations do not occur in the Wadden Sea. Sediments prevail throughout the region; only some pebbles and a few boulders are scattered locally. The sand is of fluvial and glacial origin, redistributed by currents and waves in the southern North Sea. The fine clay fraction in the sediments is thought to be primarily derived from recent riverine sources.

Sediments display a progressively shoreward-fining grain-size gradient. This gradient commences with shoals and sand flats in seaward sections, followed by mixed flats and, finally, mud flats fringing the mainland shore and sometimes occurring along tidal divides. Sandy tidal flats comprise 75%, mixed flats 18% and mud flats 7% of the back-barrier intertidal area. Almost all subtidal sediments are sandy. This dominance of sand is explained by the fact that the Wadden Sea is primarily created by relatively strong forces of the sea and a weak contribution by rivers.

Most of the supratidal marshes are composed of clay and peat of mainly terrestrial origin. The finer the sediments, the higher the biogenic share

Tidal flats and channels (Photo: Hubert Farke).

in their formation. In the salt marshes the retention capacity of the vegetation for fine particles is high. On mud flats, a bio-film of microalgae retains fine deposits. Also seagrass beds retain fine sediments, at least seasonally. Biogenic reefs of suspension-feeding molluscs locally enhance the mud content of sediments with their bio-deposits. Conversely, the abundant lugworms on the tidal flats of the Wadden Sea bioturbate the sediment and prevent fine-particulate accretion. These marine worms also contribute to the dominance of sandy tidal flats. Similarly, as Darwin described the role of earthworms in the shaping of the landscape in England, lugworms shape the appearance of the tidal flats and the spatial relation between mud and sand flats in the Wadden Sea (see also under section tidal flats).

Extensive molluscan shell beds which occur alongside tidal channels are a further biogenic contribution. These shells are a token of the high benthic filter-feeder production in the Wadden Sea. Together with a few stones and boulders, these shell beds provide the only natural hard substrate in an otherwise soft sediment environment.

Soil formation on sandy barrier islands is a slow process, because in the dry dunes the vegetation is scarce and often dominated by very slow-growing dry grassland or heather. Developing soils often become soon buried under sand blown in by the wind. In dune slacks, highly acidic soils occur with beginning peat formation. However, this remains insignificant because of the ephemeral nature of most dune slacks.

Salt marshes, on the other hand, may form clay soils of considerable magnitude and duration. Marsh soils grow upwards layer by layer with each inundation during spring-tides or tides amplified by strong onshore winds. The topography of salt marshes often shows a bewildering pattern of meandering creeks, irregularly shaped ponds and puddles, and the marsh surface is further diversified by a mosaic of vegetation types.

Deposits are supplied with waves from the sea. The seaward edges of salt marshes tend to grow faster and higher than the landward parts, because coarse-grained sediments deposit faster than alluvial mud particles. This process often generates inverted wedge-shaped salt marsh profiles. In salt marsh depressions soils become anoxic under water-logged conditions and vegetation may die back. Salt marsh puddles and ponds arise. These may become connected by creeks, which gradually become deeper and wider towards the tidal flats. Where adjacent tidal flats do not keep up with sea level rise as the salt marshes do with their sediment accretion, waves may attack salt marsh edges and cause erosion. This leads to salt marsh retreat and a possible advance of the tidal flats. Under sheltered conditions, the reverse process is initiated by pioneer plants growing into the upper tidal zone and trapping sediments where vegetation is getting dense.

In estuaries and landwards, salt marshes grade

into brackish and freshwater reed marshes. The latter may also develop mangrove-like stands of willows, but this usually takes place outside the Wadden Sea upstream in the estuaries. At such sites peat formation commences. The most common peat is formed by the reed, *Phragmites australis*. It also dominates in clods of peat underlying tidal sediments or recent salt marshes. These have developed during a time of lower sea level, then became inundated, soaked with seawater and subsequently buried underneath marine deposits.

These fossil peat layers were excavated during medieval times on a large scale. The peat was dried, then burned and the salty ash was commercially exported. This provided a major income but also lowered the level of the terrain significantly. During storm tides much of these peat mining areas became inundated and then covered again with marine deposits. Particularly around the *Halligen,* traces of former peat mining are still visible and are now to be found in the tidal zone.

In the long term, much of the accumulated clay and peat became recycled. This is caused by the dynamic interplay between the advance of salt marshes into tidal flats by progressive salt marsh pioneer plants and by salt marsh retreat as an effect of wave erosion. The balance is sensitive to sea level, height of waves and the sediment supply. Hence, a shifting of shorelines back and forth in the course of centuries has been an inherent property of sheltered shores in the Wadden Sea. At the more exposed shores, shifts in shorelines are driven entirely by physical forces. This is the case at the seaward beaches of the barrier islands. Here, however, the salt marsh clay that had developed on the sheltered leeward side of the islands and then became overtopped by migrant dunes is finally showing up again at eroding seaward beaches as circumstantial evidence of landscape dynamics in the Wadden Sea.

Habitats

Habitats in the transition zone between the land and the sea are the product of intricate interactions between physical properties and biological activities. The spectacular dunes on the barrier islands give evidence to the ongoing contest between aeolian mobilization of sand and biotic stabilization. Salt marshes grow out of the sea by a dense vegetation trapping deposits during inundation, while at the same time waves erode the edges. Mussels attach to each other, accumulate sediments over the years and successively provide habitat to more and more species until in a severe storm or a winter with floes of ice scours it all away. Less obvious are the habitat maintaining activities of lugworms, which by their continuous recycling of surface sediments keep a sand flat sandy and prevent it from becoming a mud flat. Without this secret work of worms, about 3,000 km² of rippled sand would be smooth and slimy.

The habitats of the Wadden Sea show in a fascinating way how in the biosphere an interplay between physical forces and biological activities generates conditions for life in a fragile balance. People can only grasp this in such a natural landscape, where the physical forces are strong, biological activities high, and the basic materials are soft sediments which readily change their configuration. This is strikingly exemplified in the Wadden Sea along an offshore-inshore gradient and from deep water up to the highest dunes (Fig. 2.7). The Wadden Sea provides a multitude of transitional habitats with tidal channels, sandy shoals, seagrass meadows, mussel beds, sandbars, mudflats, salt marshes, estuaries, beaches and dunes. In this chapter on habitats, the structure of the Wadden Sea Plan (see chapter 5) is adopted. According to that the 'offshore area' is not a habitat as such. However, there are characteristics which justify consideration as such in this chapter.

Offshore belt

The transition between the Wadden Sea and the North Sea may vary with regard to the aspect considered. In fact, there is a continuum between the characteristics of inshore and offshore areas, and the offshore part of the Wadden Sea is operationally defined here as the zone seaward of a line connecting the barrier islands and high sand bars, and extending into the North Sea down to the –15 m depth contour. This belt has no tidal flats and drops off rather smoothly towards the open North Sea but does not fully comply with it in terms of the biota present.

This offshore belt roughly comprises 6,000 km² and average water depth is around 10 m. Along the Southern Wadden Sea this zone varies between 10 and 25 km in width. In the Central and Northern Wadden Sea the offshore belt is wider and varies between 20 and 50 km. This transitional zone is only partially included in the nominated property, which particularly extends seaward off the Ems estuary and off the islands of Sylt and Amrum. This offshore belt has to be taken into account regardless of boundaries because physical processes and migrations of organisms reach across. The offshore zone is to a major extent within the Wadden Sea Area and hence also subject to protection and management in the context of the trilateral Wadden Sea Cooperation. Furthermore,

Figure 2.7:
Major habitats in the Wadden Sea Area.

the larger part of the offshore zone is subject to protection under the EU Habitats and Birds Directives and other international conventions such as the Ramsar Convention.

Hydrologically the offshore belt is part of the coastal long-shore current and cannot be considered to constitute a distinct water body. Due to the tides it exchanges an average volume of 15 km³ of water twice daily with the tidal area. This exchange is presumably several times more intense than the exchange with the open North Sea and adjacent coastal areas to the west and north. In terms of sediment, the offshore belt is part of a sand-sharing system with the barrier islands and tidal area. It is assumed that almost no sand is transported across the 15 to 20 m depth contour. However, this may happen during exceptionally heavy storms with waves affecting the bottom of the sea as far down as 50 m. Traces of such disturbances have been observed in the benthic fauna at such a depth. The regular sand-sharing system between the offshore belt and the islands, the outer sand bars and the tidal area is a vital condition for the resilience of the coastal system when responding to changes in tidal area and sea level and to disturbances caused by heavy storm tides.

The ecology of the tidal area and the open North Sea is intimately linked through the offshore belt. Phytoplankton blooms often commence in this zone. Here, turbidity is low enough for sufficient light availability in the water column and nutrient concentrations sufficiently high for rapid uptake. Both together provide an optimum for the development of microalgae suspended in the upper layer of the water. Through the tidal inlets, this offshore primary production supplies the benthic suspension and deposit feeders in the shallow inshore zone. In other words, phytoplankton originating offshore feeds inshore zoobenthos.

The benthos of the offshore belt differs from that of the open North Sea by being particularly adapted to the instability of the substratum and the occasional disturbances when waves hit the

ground. Macroalgae are absent except where boulders provide isolated firm substratum. Most invertebrate animals are highly mobile to cope with shifting sands. Nevertheless, also tube-building worms such as the sand mason (*Lanice conchilega*) take the chance of intermittent stability, settle in dense assemblages and then manage to stabilize the sand. This provides habitat for other benthos and diverse assemblages arise until scouring waves destroy this worm-based habitat after a year or more.

Particularly the ebbtidal deltas in front of the tidal inlets provide a habitat with continuously shifting sands. Few organisms are adapted to live there but those who can are highly specialized such as stout little worms (genus *Ophelia*) which coil up once disturbed. Sand grains stick to their skin and make them heavy enough to soon return to the bottom in turbulent waters. Tiny amphipods (Haustoriidae) have evolved shovel-like legs to dig through the sand but also swim quickly in the water by paddling with their broad legs.

Ecologically the most important function of the offshore belt for the tidal area may be its role as a spawning site for organisms the larvae of which become transported into the tidal area and grow up there under highly nutritious and warmer conditions in spring and summer. This applies in particular to brown shrimp (*Crangon crangon).* It is nowhere as abundant as in the Wadden Sea and functions as a key predator on small benthic invertebrates (see also section on population of sentinel species). The shrimp fishery focuses on the offshore belt, because this is where the large adults stay while the smaller shrimp populate the tidal area. In former times, the rough surf in the offshore belt confined shrimp fishery to beam-trawling in the more sheltered back-barrier area but this limitation has been overcome by larger and better motorized vessels.

What has been exemplified with the brown shrimp also applies to several species of flatfish, with the plaice (*Pleuronectes platessa)* being the most abundant and the sole (*Solea solea)* (see also section on population of sentinel species). With the exception of the flounder (*Platychtys flesus),* adult flatfish stay mostly offshore while their larvae drift inshore, metamorphose and then start feeding on benthic prey on muddy tidal flats. Before winter commences the young return offshore.

For many other fish and invertebrates, the offshore belt serves as a refuge during winter, when temperatures in the tidal area become too cold. Particularly during exceptionally severe winters, this refuge function becomes vital for populations to survive. Partly, survival is achieved by satellite populations in the offshore belt while the larger part of the population occurs in the tidal area. This is the case with the cockle (*Cerastoderma edule)* which is highly susceptible to freezing conditions. Following a severe winter, offshore satellite populations may supply the larvae for recolonizing the tidal area. More mobile organisms, including worms which usually stay in the bottom, have been observed to escape from freezing conditions in the tidal area with the ebb current and then resettle in the offshore belt from where they may return in the next spring.

Terns in summer and Eiders and Common Scoter in winter often feed in the offshore belt. For individual harbour seals (*Phoca vitulina)* tagged with transmitters it has recently been shown that most feeding trips of these seals occur in the *offshore* belt and even beyond. The same probably applies to the larger grey seals (*Halichoerus grypus).* Both species aggregate for resting on emerging sand bars in the ebbtidal delta. Most sightings of the native whale species in the Wadden Sea, the harbour porpoise (*Phocoena phocoena),* are made in the offshore belt, and these also bring up their young in this zone. A hot spot for harbour porpoise recruitment is off the islands of Sylt and Amrum, and therefore this offshore region has been included into the National Park of the Schleswig-Holstein Wadden Sea (see also section on population of sentinel species).

In conclusion, although geographically not obvious, the offshore belt adjacent to the tidal area is an essential habitat for the Wadden Sea ecosystem. Phytoplankton blooms are transported from the offshore belt into the tidal area. Also larvae of benthic fauna and fish take the same route. Shrimp, fish, diving birds and marine mammals readily commute between inshore and offshore parts depending on developmental stage or season. In severe winters the offshore belt provides an important refuge for the survival of populations otherwise confined to the tidal area. The offshore belt is also an important part of the coastal sand-sharing system.

Tidal area

The occurrence of tidal areas is confined to oceanic coasts with notable astronomical tides. Similar habitats arise where in extremely shallow waters on- and offshore winds cause windflats and marshes to be irregularly emerged and submerged. The general appearance of tidal areas greatly differs between climate zones, substrate

Lütje Hörn
(Photo: Hubert Farke).

types and bio-geographic regions. The distinction made here between an offshore belt, tidal area, estuaries and salt marshes cannot be applied to other coastal regions where barrier islands are absent, where riverine influence is a key factor or where salt marshes or even mangroves in tropical and subtropical zones occupy to a large extent the tidal zone. The singularity and exceptional spatial extent of the Wadden Sea may justify habitat distinctions appropriate specifically for this coastal region.

The tidal area of the Wadden Sea comprises the tidal flats, subtidal shoals and gullies of the back-barrier region and in the Central Wadden Sea. The boundary at the North Sea side is determined by an artificial line between the tips of barrier islands and outer sand bars. The borders to the estuaries are determined by salinity, the average 10 psu isohaline at high water in the winter situation.

The tidal area includes the most characteristic habitats of the Wadden Sea. Above all, the tidal flats up to the horizon are a phenomenon that cannot be found anywhere else on such a large scale. The tidal flats of the Wadden Sea form the largest unbroken stretch of mud and sand flats in the world. At low tide, the tidal flats are exposed over about half of the tidal area. The other half is subtidal shoals and deep gullies which branch into ever smaller creeks and runnels intersecting the tidal flats. Embedded in this topographic and sedimentary matrix are biogenic habitats such as seagrass meadows and mussel beds which will be given special attention.

Tidal flats

Twice a day a spectacle happens. Land slowly rises from the sea and then is irresistibly engulfed again by the flooding waters. The bottom of the sea meets the horizon and invites the observer to take a long walk. However, the walker has to be cautious. Numerous runnels, some creeks and, finally, deep gullies may block the way and require swimming. Pushed by onshore winds the flood may return sooner than expected from the astronomical tide tables published for the various localities within the Wadden Sea Area. Therefore, guided tours are offered to the visitors, explaining not only the tides but also revealing the secrets of hidden life in the marine sediments under our feet.

The sediment surface is almost completely covered by microscopic algae, and often their photosynthetic activity can be seen by bubbles of oxygen in puddles of water. Small snails, in particular, graze on these algae. Snails can be so numerous that what first appears to be coarse grained sediment is actually one snail shell next to the other of the common mud snail (*Hydrobia ulvae)*, reaching densities of up to 120,000 snails per m². These are at most a few millimetres long. With their rasping tongue they feed on diatom algae and bacteria films attached to sand grains or to the houses of their fellow snails. The snails in turn are hosts to a specific community of parasites, are prey to crabs, shrimp and fish, and some birds such as Shelduck (*Tadorna tadorna)* at times prefer to forage on this abundant food.

These little snails prefer the upper tidal zone where most of the diatom algae occur on muddy flats. Young snails, however, drift downshore to feed on diatoms attached to individual sand grains, which are hardly smaller than the young snails. Therefore predators find it difficult to separate snails from grains of sand. This helps the young snails to survive. In late summer, when grown up, snails drift back to the upper tidal zone where their parents have remained.

Most of the marine organisms in the tidal sediments are rather small. Up to one hundred nematodes can be found per cm^3 of surface sediment. However, the tidal flats of the Wadden Sea also harbour large sediment fauna. Most notable is the lugworm (*Arenicola marina*, Polychaeta) which may be up to 20 cm long and as thick as a pen. This worm stays well below the sediment surface at the base of its U-shaped burrow, out of reach to most predators. Its food slides down a funnel from the sediment surface. The worm ingests sand, digests adhering microalgae and bacteria, and then egests a fecal string of clean sand back to the surface, coiled up like cooked spaghetti. The faecal mounds lie scattered all over the sediment surface, giving the tidal flats of the Wadden Sea a highly characteristic surface topography (see also under section soils and sediments).

Lugworms irrigate their burrows with water from above to supply their gills with oxygen and thus build up an oxic environment in an otherwise anoxic sediment with toxic sulphides. This creates a number of microoxic niches alongside burrows which are utilized by minute worms, copepods and amphipods. Some of these worms have never been found away from lugworms burrows (i.e., *Typhlopolycystis rubra, Scoliopharyngia arenicola, Coelogynopora faenofurca*) and constitute a highly specialized faunal component.

The almost ubiquitous lugworms displace other fauna by destabilizing the sediment surface layer which is recycled 10-20 times per year through the guts of these worms. Even their own juveniles are relegated to marginal zones until big enough to join the adults. Another victim of the bioturbation activity of lugworms is the small mud shrimp (*Corophium volutator,* Amphipoda). It dwells in much smaller U-shaped burrows. The young ones are suspension feeders and the older ones collect sediment particles which are individually taken in between the mouth appendices to scrape off palatable bacteria and microalgae.

This amphipod is restricted to a belt in the upper tidal zone because here predation by fish and the brown shrimp (*Crangon crangon)* is rather limited. However, during low tide exposure there is a specialized predator in the form of the nemertine worm (*Tetrastemma melanocephalum*). This sneaks into burrows and captures the amphipods with a poisonous proboscis. This predator is only successful during low tide when the amphipods cannot escape by swimming. Also at low tide, the common redshank (*Tringa totanus)* prefers to forage on *Corophium*. This is convenient to the wading bird because it breeds in adjacent salt marsh vegetation, just high enough to hide its nests and young from gulls and raptorial birds.

Almost all organisms living in the tidal sediments are of marine evolutionary origin. Those of terrestrial or limnic origin are an almost negligible minority on the tidal flats of the Wadden Sea. However, their adaptations to the hostile marine environment are striking. The small roof beetle (*Bledius spectabilis)* feeds in the upper tidal margin on biofilms composed of blue-green bacterial colonies (Cyanobacteria) and lives in vertical burrows which can be sealed during inundation. The beetle survives in a chamber filled with air. When inundations become too frequent during autumn and winter, beetles leave the tidal zone to hibernate in the upper salt marsh.

Waders and gulls also follow the ebbing tide down to the lowest level to forage for prey left behind in shallow puddles and prey hiding underneath the surface of the sediment. Evidently these tidal flats are so rich in resources that birds fly in from far away. However, birds do not forage evenly throughout the tidal zone. Their preferred prey may occur in distinct belts or patches, differs in sizes and abundance between mud and sand or is not everywhere easily accessible at all times. This is where the large coherent tidal area pays for the foraging birds. They are able to optimize their foraging strategy by selecting the most favourable sites at a given time.

A most graceful wading bird in black and white is the Avocet (*Recurvirostra avosetta)*. It breeds with about 10,000 pairs in the Wadden Sea Area and 46,000 birds visit during autumn migration and then leave for wintering in West Africa by the end of October. The main feeding grounds are the mud flats along the mainland coast of the Wadden Sea. There they prey on worms and, in particular, on the mud shrimp (*Corophium volutator)* (see above).

Time is short for birds which rely on low tide exposure to catch sufficient prey. This is particularly the case when the Wadden Sea is visited for a stopover on the long flyway between southern wintering and northern breeding grounds. Refuel-

Tidal flat on the island of Ameland (Photo: Jan Huneman).

ling has to be accomplished in a short time. The Wadden Sea is ideal for that purpose. The vast extent of tidal flats and the hunting prohibition keep human disturbances at a minimum. Guided tours for visitors usually follow a fixed path, and birds are able to become accustomed to such predictable events.

The density and diversity of the tidal flat fauna in the Wadden Sea are higher than in most other coastal environments. The average biomass is about 50 g dry organic weight per m^2 and this is 10-20 times higher than in the offshore area. Of further importance is the fact that much of this biomass is rather easy to access for fish when the tide is in and birds when the tide is out. For example, preying on earthworms on dry grassland is much more difficult for a bird than feeding on ragworms, cockles or mud shrimp on a tidal flat.

The benthic biomass production on tidal flats is so high because there are two sources of food. One is the microbial and microalgal production on the sediment surface and the other is a phytoplankton import with the tides from offshore waters. Further, these benthic and pelagic unicellular microalgae are much easier for invertebrate fauna to consume than larger plants. Thus, food webs in the tidal area are highly efficient.

In contrast to many other habitats, all these interactions between organisms from microbes to birds, as well as between organisms and their habitat by adaptations and modulating effects are highly conspicuous and often directly observable on the tidal flats. A guided walk across tidal flats may take the place of many formal lectures and textbook chapters on basic and applied ecology. The tidal flat habitat reveals natural processes that are easily extended beyond the horizon to understand the earth system. Also, the consequences of climate change with the entailed sea level rise are readily apparent.

There are various specific types of tidal flats such as macroalgal mats, shell beds, soft mud, fine and coarse grained sand flats, seagrass meadows and mussel beds. The latter two are singled out for closer description.

Seagrass meadows

Seagrasses are submersed flowering plants which have their evolutionary origin in freshwater and from there have colonized shallow coastal waters with about 60 species world-wide. Typically for the harsh environment of the Wadden Sea, only two of these seagrass species have managed to become established in the area. However, due to its changeable environmental history, the Wadden Sea populations of both species have accumulated a much higher genetic diversity than other populations along the European Atlantic coast. This is an example where versatility of individual species has been favoured in the course of evolution over high species diversity.

The two species, *Zostera noltii* and *Z. marina*, often called dwarf seagrass and common seagrass, respectively, tend to occur in mixed stands on the tidal flats. The dwarf seagrass grows in very dense

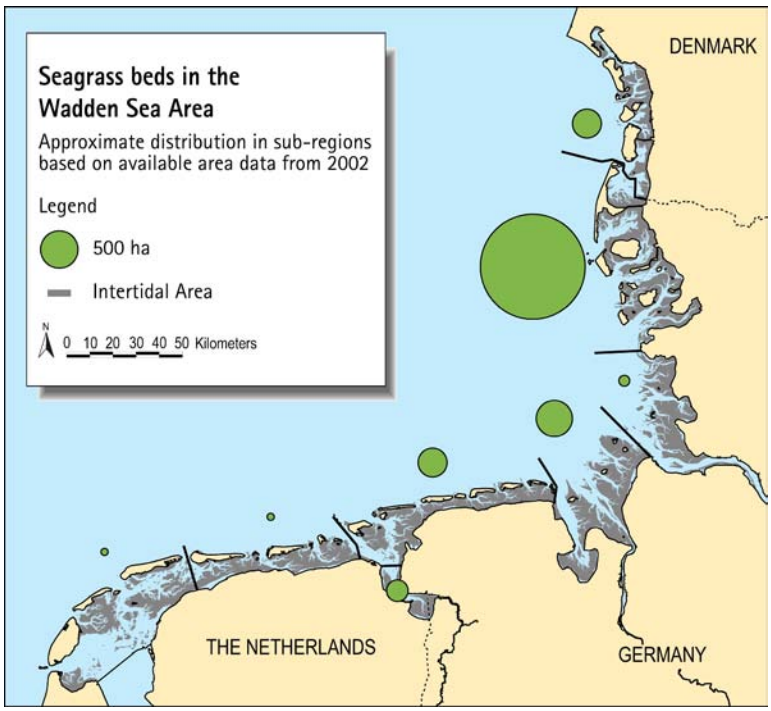


Figure 2.8: Distribution of seagrass beds across parts of the Wadden Sea in 2002 (source: QSR 2004).

patches which trap sediment particles transported by tides and waves. Consequently, this accretion of sediment causes dwarf seagrass to grow on slightly elevated hummocks, while the interspaces between hummocks are the preferred habitat of the common seagrass. This species grows more scattered as individual plants and this pattern does not facilitate sediment accretion but favours erosion. Physiological measurements have shown that the dwarf seagrass is more tolerant to low tide desiccation than the common seagrass. This is a striking example of how coexistence between potential competitors is mediated by their habitat modifications.

Zostera beds provide a substrate for fouling algae which, in turn, are grazed by snails and other invertebrates. Snails, in fact, are essential for keeping seagrass blades sufficiently clean from fouling algae. Otherwise, photosynthesis would be inhibited by shading the chloroplasts of the seagrass. The canopy and rhizomes offer protection for small animals such as juvenile bivalves, crustaceans and fishes, which utilize the beds as a nursery. It is peculiar to find marine invertebrates specializing on the inflorescence of seagrass as a microhabitat which remains filled with water throughout the tidal cycle. The polychaete worm, *Polydora cornuta,* has been encountered regularly in the inflorescences raising its larvae there.

In autumn, *Zostera* beds constitute a preferred food for brent geese (*Branta bernicla)* and widgeon (*Anas penelope)*. Although these birds thin out blades and rhizomes, dwarf seagrass has been observed to grow more vigorously at sites where grazing took place in the preceding year as opposed to sites where grazing was inhibited. Grazing by these birds is apparently beneficial.

In the Wadden Sea, most beds are to be found in the mid to upper tidal zone along the leeside of islands and high sand bars, as well as along sheltered parts of the mainland coast. In addition to the protection offered by islands against waves created by the prevailing westerly gales, clay and peat of marsh soils submerged long ago provide a firm substrate for the roots. There, seagrass is safe from getting uprooted by wave erosion.

This is an example of how the remains of terrestrial habitats, long gone in the wake of sea level rise and storm tide devastations, influence the spatial pattern of a marine habitat centuries later. It may also explain why most seagrass meadows are found in that part of the Wadden Sea where in medieval times floods drowned an extensive marsh (Fig. 2.8). Probably, the prevailing high sediment dynamics in the Wadden Sea are a major limiting factor for seagrass occurrence, leaving most of the tidal flats bare of rooted plants.

Mussel beds

Mussel beds are generally known from rocky shores. However, in the Wadden Sea mussels have managed to develop persistent beds on sediments. Blue mussels (*Mytilus edulis*) occur in a belt from

Seagrass (*Zostera*) in the Jade Bight (Photo: Gerald Millat).

slightly above to a few meters below low tide line. Mussels have the ability to attach to each other by byssal threads. This has the advantage that aggregates of interconnected mussels resist translocation by waves and currents. It allows them to live upon the sediment surface without digging into the sediment as other bivalves usually do.

On sedimentary flats mussels usually aggregate into coherent mats which completely cover the sediment. Some 1,000 to 4,000 mussels per m^2 may occur. They mostly form elongated beds perpendicular to the main flow of tidal waters. This minimizes intraspecific competition for the suspended food which they filter out of the tidal waters. It is the balance between the benefits of living tossed together and the disadvantage of competing for food that generates the rather specific fractal spatial pattern of mussel beds in the Wadden Sea.

Mussels cause the deposition of a large amount of suspended matter by their faeces and pseudofaeces as well as by creating a rough surface with sheltered interspaces. This causes mussel beds to rise above the ambient sediment surface up to half a meter or more. Sedimentation may be further enhanced by macroalgae which grow attached to the mussels. Sediment is partly deposited within the bed, partly in its surroundings or even, after storms, in land reclamation fields and on salt marshes. The importance of mussel beds for the sediment budget of the Wadden Sea has been stressed.

Mussel beds are very active in the breakdown of organic matter. While mussels contribute to a very rapid remineralisation and release significant amounts of ammonia and silicate, the main decomposition of organic matter is carried out by bacteria in the faecal material. One can conclude that mussel beds increase the turnover rate of organic matter through filtration, deposition and breakdown of organic matter and that they supply dissolved nutrients for primary production.

Mussel beds provide a natural hard substratum of considerable extent and this hosts a number of associated algae and invertebrates which otherwise would be absent from the Wadden Sea. A good example is the bladder wrack (*Fucus vesiculosus)*. Thalli of this macroalgae are fixed by mussels with their byssal threads. In this association the bladder wrack merely grows vegetatively and lacks the characteristic bladders. Presumably, bladders would cause uplifting together with the mussels underneath and thus would be detrimental. A small periwinkle (*Littorina mariae)* grazes specifically on this wrack and is never found outside the mussel beds. These snails have been shown to be genetically distinct from populations which dwell on rocky shores.

More than one hundred allied species are to be found in mussel beds. Barnacles grow on the shells and create a rough surface with numerous small niches. Although barnacles lower the rate of growth and survival of the mussels they have overgrown, they also provide ideal settlement

Blue mussel beds (Photo: Gerald Millat).

conditions for the recruits of the mussels. This is an interesting case of interactions between species, where disadvantages and benefits may alternate. In the short term and on the scale of an individual mussel, the negative effects of fouling prevail, while, in terms of the persistence of mussel beds and the mussel population as a whole, the positive effect of facilitating recruitment outweighs the negative one. Especially deposit feeding worms profit from the organic matter that accumulate underneath the layer of mussels, which also shields from predators above. Juvenile shore crabs (*Carcinus maenas)* prey on small mussels and find shelter underneath the big ones to keep away from their own predators.

Mussels in the Wadden Sea tend to be heavily infested by the shell-boring polychaete worm, *Polydora ciliata.* This weakens shell strength and facilitates predation by shell-crushing predators like crabs and Eider ducks. The biomass of mussel beds is 25 times higher than in adjacent bare sediment flats. This attracts wading birds and gulls to intertidal mussel beds and diving Eiders to subtidal beds. More than 200 birds per ha of mussel bed have been counted. This amounts to 25% of the wading birds in the Wadden Sea feeding on mussel beds that cover only 1% of the tidal area. The most important predators consuming mussels are eider ducks (*Somateria mollissima*) and oystercatchers (*Ostralegus haematopus*). These birds can shift their diet between mussels and cockles depending on availability. Herring-gulls (*Larus argentatus*) feed preferentially on young mussel beds.

Recently, introduced Pacific oysters (*Crassostrea gigas)* began to invade mussel beds. Oyster spat attach directly to individual mussels, grow larger and suffocate the mussels underneath. However, oysters, in turn, provide shelter to young mussels which thrive well in between the much bigger oysters. Thus, although mussel beds appear to be transformed into oyster reefs, mussels nevertheless manage to persist. Also, the species formerly associated with mussel beds continue to exist in the new association.

Subtidal shoals and gullies

The diversity of epibenthic organisms which live upon the sediment surface is higher in the subtidal zone than in the intertidal and also than in the wave-swapped offshore belt seaward of the barrier islands and sand bars. In the back-barrier subtidal zone, species which cannot endure low tide exposure but take advantage of the richness of food and the shelter from strong waves join species which have their main occurrence in the intertidal zone. Sponges, tunicates and colonial hydrozoan polyps which attach to shell beds are mostly confined to subtidal shoals. The most beautiful colonies are formed by polyps of the species *Sertularia cupressina.* In the past, these were dredged, dried and then stained in bright colours to use for decorative purposes, until substitutes made out of plastic replaced them on the market.

Reefs have been created by generations of worms which build their tubes out of sand grains and attach tubes to each other. The species *Sabel-*

Iaria spinulosa is capable of building massive solid reefs up to 50 cm high. Reefs have been reported in the past in the German part of the Wadden Sea only. Bottom trawling and changes in water current conditions are considered to be the main reason for the decline of Sabellaria reefs. Since trawling has been shifted mostly to the offshore belt, one may expect these *Sabellaria*-reefs to recover. Similarly, European oyster beds which disappeared, partly due to overexploitation already at the beginning of the twentieth century, may eventually come back. The subtidal bottom provides habitat to the starfish, *Asterias rubens.* These seem to be excluded from the intertidal zone because gulls at low tide are particularly fond of this prey.

The subtidal shoals and deep gullies are also important for the intertidal fauna as a refuge when seasonal conditions become too harsh in the intertidal zone. Particularly the young crabs, shrimp and fish which exploit the tidal flats soon begin to migrate with the ebbing tide into the subtidal zone and then return with the next flood. Some, like the shore crab (*Carcinus maenas),* hibernate in the subtidal but from spring onwards begin to commute with the tides between subtidal and intertidal zones. Crabs are very important predators, often decimating bivalve recruitment entirely.

Estuaries

Estuaries can be defined as tidally influenced transition zones between marine and riverine environments. World-wide, estuaries and deltas constitute the main coastal wetlands. The Wadden Sea is different in this regard. Although estuarine habitats are present, they are not a dominant feature and are small in size relative to the marine parts of the Wadden Sea. Nevertheless, they are of high relevance for the Wadden Sea ecosystem for various reasons: (1) they supply riverine inputs such as nutrients and toxic substances, (2) they are pathways for diadromous fish such as flounder (*Platichthys flesus*), smelt (*Osmerus eperlanus*) and eel (*Anguilla anguilla*), and (3) they form a specific habitat characterized by a strong variability of salinity, tidal range and turbidity. From an ecological point of view, they are important for the migration of a number of species and, additionally, they are inhabited by various obligate brackish-water species and thus are of special importance for conservation purposes. However, compared to the Wadden Sea, the estuaries have been strongly altered by human activities and only some parts are protected as nature reserves. Only the Ems estuary is partly located in the nominated property. This estuary is a mesotidal coastal plain estuary with extensive muddy tidal flats.

There are also many sluices which discharge freshwater into the Wadden Sea. Some are small with only some m^3 per second, but in the Western Dutch Wadden Sea a sluice in the Afsluitdijk of Lake Ijssel discharges around 500 m^3 per second in average. Since discharge is limited to low tide periods, more than 2,000 m^3 per second are discharged during such intervals, which is three times larger than that of the Elbe. This kind of drainage creates estuarine conditions – although not completely natural – in this part of the Wadden Sea. However, the main difference between the Wadden Sea and other coastal wetlands is, besides its outstanding size, the prevalence of marine (euryhaline and polyhaline) conditions in the tidal area.

Salt marshes

Salt marshes and mangroves are composed of upright vegetation. These plants are of terrestrial evolutionary origin but tolerate marine waters. Elsewhere in the world, they often manage to occupy the tidal zone down to about mid tide level and exhibit a vegetation height of more than one meter. This is not the case in the Wadden Sea. Mangroves are absent, because of low temperatures, and salt marshes are mostly confined to the supratidal zone not regularly flooded at each high tide. Only a few pioneer plants extend their range into the tidal zone down to about neap tide level, which is equivalent to three hours of submersion per tidal cycle on average (Fig. 2.9). Furthermore, Wadden Sea salt marshes rarely exhibit vegetation heights above one meter. Grasses and herbs or low shrubs of less than half a meter dominate. Trees do not occur in these salt marshes.

Vegetation and topography

Wadden Sea salt marshes are naturally open grasslands with habitat specific plants of great beauty and diversity. Salt marshes show a great variety of appearances. They can be rich in flowers, they can exhibit a rather diverse mixed assemblage of specialized plants and generalists adapted to disturbed regimes or they can be completely dominated by one or two grass species forming monotypic stands of vegetation. In general, diversity increases from the pioneer zone to the rarely submerged upper salt marsh belt. Highest diversity is found in sandy salt marshes and in the transition zone to dunes. Ranges of salt marsh plant populations are generally limited in the seaward direction by their ability to withstand marine

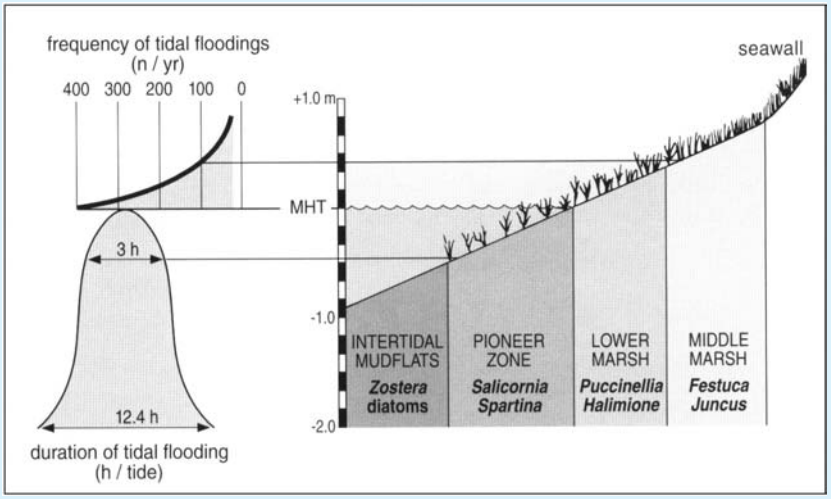


Figure 2.9: Zonation of salt marshes in relation to duration and frequency of tidal floodings and marsh elevations (Source: Esselink, 2000).

inundations. In the landward direction they tend to be limited by competition, particularly shading by other plants.

Accordingly, the most specialized salt marsh plants are to be found in the lower zone, while the upper salt marsh also includes generalist plants of wide tolerance which may be common outside salt marshes as well. Plants in a salt marsh either adjust to salinity or regulate the salt content in their cells. Some of the salt marsh halophytes are succulents, compensating a high salt content by extending the vacuoles in their cells (i.e. *Salicornia* spp., *Suaeda maritima*). Others are capable of excreting salt through special glands (i.e., *Limonium vulgare, Spartina anglica*) or salt bladder cells which fill with salt, then die or burst, releasing salt from the plant (i.e., *Atriplex* spp.). Still others simply seem to accumulate salt in their leaves until they die at the end of the season (i.e., *Juncus gerardi*).

Under conditions of sea level rise, salt marshes will persist as a habitat by accretion. As the vegetation grows older, a gradual landward shift of the zonation may occur. Accretion is accomplished by inorganic sediments imported during inundations from the seaward tidal flats and by organic matter which is supplied by the marsh vegetation itself. Vertical accretion rates tend to decrease with increasing marsh elevation and with increasing distance from tidal flats or creeks meandering and branching across salt marshes (see also under section soil and sediments). Vegetation height and density also facilitate accretion rate. These variations generate a rather irregular topography and a complex mosaic-like vegetation pattern. Further, water-logged pans arise which are bare

Salt marsh (Photo: Klaas Kreuijer).

Salt marsh on the island of Griend (Photo: Jan van de Kam).

or with scarce vegetation. Instead of accretion, these pans may erode into salt marsh ponds, and these may eventually merge into a creek. It is basically the vegetation which generates this highly complex and irregular dynamic habitat mosaic of salt marshes.

While salinity may be high in salt marsh pans during dry periods, salinity is low at the upper end of salt marshes where these are bordered by dunes. Here, freshwater seepage is common, creating brackish water habitats. In the absence of grazing, often the reed (*Phragmites australis)* takes over as it also does in the inner parts of estuaries. For example, in the Elbe estuary, outside the nominated property, under macrotidal conditions the reed grows up to 4 m in height.

Depending on sediment supply and wave action, the seaward edge of salt marshes may show a variable width of pioneer zone composed mainly of glassword (*Salicornia* spp.) and the cordgrass (*Spartina anglica)*. While the former are annuals and rather short, the latter grows in dense tussocks which extend laterally and, finally, may merge into continuous belts. At sites with low sediment supply at the seaward edge, salt marshes become cliffed and retreat, and no progressive pioneer zone develops into the tidal zone. On a larger scale, this edge instability may not be taken as a threat to the habitat, because the eroded material may accumulate elsewhere, allowing pioneer vegetation to colonize anew.

Animals

While the organisms occurring on tidal flats are predominantly of marine origin, in salt marshes those of terrestrial origin by far outnumber marine algae and marine invertebrates. However, an abundant marine snail, very similar to the abundant mud snail (*Hydrobia ulvae)* on the tidal flats, is *Assiminea grayana*. It grazes on microalgae in the moist microenvironment underneath dense vegetation. Interestingly, although the adults are confined to the supratidal salt marshes, their larval development is still planktonic in the tidal waters. This guarantees wide dispersal. This prosobranch marine snail with gills often shares the same habitat and feeding mode with a pulmonate snail of terrestrial origin (*Ovatella myosotis*), and as such is equipped with a lung to breathe air.

Aquatic species of the microfauna are particularly adapted to highly variable moisture and salinity in salt marshes. A study on turbellarian worms revealed that many species are of the specialized brackish water fauna. They thrive in salt marshes, where salinity fluctuates between inundations during storm tides and periods of heavy rain. When it gets too dry or otherwise adverse, some of these species even encyst and then wait in this dormant stage for more benign conditions to come.

Most invertebrates in the salt marshes are terrestrial arthropods. Many of them show morphological adaptations to prevent saltwater from intruding into their bodies. Some have a dense fur, like a hair coat, which ensures that an air film is trapped between the hairs when the organism is covered with water. Such films of air serve as physical gills. Tolerance to salinity, osmotic and ionic regulation as well as avoidance behaviour

during periods of inundation are also quite common. On the other hand, it is curious to find spiders such as *Erigone arctica* (Micryphantidae) and *Leptorrhoptrum robustum* (Linyhpiidae) spinning nets under submerged conditions.

A common mode of life for terrestrial arthropods in order to become partially independent from the harshness of the physical environment is to adopt an endophagous or endoparasitic habit. A large proportion (ca. 60%) of coastal butterflies (mostly Microlepidoptera), as well as some beetle species, spend their larval stages inside roots, stems, shoots, leaves or flowers of saltmarsh plants. Endoparasitism by larval stages is found in more than 100 hymenopteran insect species encountered in the Wadden Sea salt marshes.

Salt marshes of the Wadden Sea make up about 20% of this habitat type along the European Atlantic and Baltic coasts. They represent an indispensable habitat for huge flocks of migratory waterfowl and breeding birds. Many just come for resting at high tide until the tidal flats become accessible for foraging again. However, salt marshes are also important breeding areas for various wading birds, terns and gulls, spoonbills and some passerines. The Oystercatcher (*Haematopus ostralegus)* is one of the most abundant breeding birds in the Wadden Sea. Highest densities are found on island salt marshes. Pairs are territorial, with an average of one pair per ha. Breeding close to the salt marsh edge in the vicinity of the tidal feeding grounds is most advantageous. Pairs have to queue for several years before finding a chance to occupy one of these superior territories. Other pairs decide on a breeding territory further away from the edge, starting earlier in life with raising young, but their overall reproductive success may be lower because they have to "leapfrog" over the territories of others in order to forage and feed their chicks. As a result, these often die of starvation.

Brent goose (*Branta bernicla)* and barnacle goose (*Branta leucopsis)* use salt marshes during spring migration to replenish their body reserves. This is essential in order to reach their distant breeding grounds. A study on salt marshes of the island of Schiermonnikoog revealed that grazing by barnacle geese improved the quality of vegetation for the birds. A positive feedback between increased grazing intensity and foraging efficiency on short-grazed lush vegetation has been revealed. This was the case for low-productive vegetation, while high-productive sites developed a dense and high vegetation unsuitable for herbivore consumption.

Modified salt marshes

In the Wadden Sea, about one third of the salt marsh area shows the natural patterns of accretion, erosion and vegetative diversification described above. Entirely natural salt marshes prevail on the barrier islands and, in the Northern Wadden Sea, also behind sandy barriers of the mainland (Table 2.2). Along most of the mainland, however, salt marshes are man-made. At the seaward edge, accretion is facilitated by means of brushwood groins. These are set up in a rectangular pattern. Groins are often up to one meter in height, constructed with two parallel rows of wooden pilings and brushwood fixed in between. Such groins are permeable for water, mitigate wave action and enhance sedimentation.

Table 2.2: Area of salt marsh types (ha) in the Wadden Sea, including the pioneer zone, except for Niedersachsen. The boundary between the pioneer zone and bare soil is chosen at 5% coverage (10% in Schleswig-Holstein) (Bakker et al. 2005). Barrier-connected salt marshes are mainly found on the sheltered parts of the islands. Green beaches are salt marshes growing on extended sand flats on the seaward side of the islands (Source: QSR 2004).

Salt marsh type	The Netherlands	Niedersachsen	Schleswig-Holstein	TOTAL
Years	1995-2002	1997	2001-2002	
1. Barrier islands				
A barrier-connected (incl. foreland)	3,500	2,820	1,130	7,450
B green beaches	380	310	0	690
C1 summer polder	0	60	0	60
C2 de-embanked (summer) polder	45	150	0	195
2. Mainland				
A barrier-connected	0	0	730	730
B foreland marsh	4,000	5,430	7,470	16,900
C1 summer polder	960	1,540	0	2,500
C2 de-embanked summer polder	295	90	0	385
3. Halligen	45		2110	2,155
TOTAL	**9,225**	**10,400**	**11,440**	**31,065**

Rainbow over a salt marsh (Photo: Martin Stock).

In addition to groins, parallel ditches are dug to facilitate drainage and to enhance vegetation settlement and growth. Small ditches lead to larger ones which debouch drainage water into the tidal flats. Draining by numerous ditches prevents water-logging. The vegetation in such man-made salt marshes was grazed intensively by livestock to keep the vegetation short, often less than the length of a finger. Under these conditions, lower and upper marshes are dominated by the grasses *Puccinellia maritima* and *Festuca rubra*, respectively. To increase the natural value of those marshes, grazing and draining have been reduced or abandoned. Today, a large proportion of the man-made marshes are allowed to grow according to the geomorphological conditions of the habitat. The landward boundary of such groin-protected and drained salt marshes is almost always an earthen seawall (dike) to prevent inundations of the hinterland. The purpose of such a foreland in front of a dike is to dissipate wave energy during storm tides.

In the Southern Wadden Sea, the upper foreland is often protected by a summer dike, which is high enough to keep out inundations during summer, while storm tides in winter may overtop such a seawall. The marshes between the summer dike and the main dike are so-called summer polders. Here, the vegetation is no longer dominated by halophytes. Summer polders mainly serve to improve livestock farming. Some of these have been de-embanked in order to restore more diverse salt marsh vegetation (Table 2.2). On the *Halligen* in the Northern Wadden Sea, a salt marsh type prevails which resembles the upper foreland along the mainland. Shores of these *Halligen* have been supplied with stonewalls to stop cliff erosion at the salt marsh edge, which tends to be much higher than in ambient tidal flats. The vegetation on the *Halligen* is dominated by *Festuca rubra* and *Juncus geradii* vegetation.

Traditionally, salt marshes were used for livestock grazing, mostly cattle in the Southern Wadden Sea and sheep in the Northern Wadden Sea. On mainland salt marshes, the grazing intensity was kept high, because it was assumed that when vegetation remained short and dense, the resulting lawns were better than natural vegetation in preventing erosion on the foreland in front of seawalls. In the meantime, it has been demonstrated that higher vegetation can function likewise. Consequently, grazing intensity is now generally reduced to allow for higher plant diversity.

In conclusion, there is quite a diversity of distinctive salt marsh types in the Wadden Sea. Most consist of a species-rich dynamic mosaic of vegetation patches. A rather monotonous grassland prevails either as a result of intensive livestock grazing or of high nutrient supply in the absence of grazing. Barrier-connected salt marshes are often entirely natural while the others are mostly man-made and/or managed for coastal protection. The barrier-connected type constitutes a rare

Beach on the island of Norderney (Photo: Imke Zwoch).

natural heritage, and the latter is a rather distinctive cultural heritage documenting the contest between man and the sea. Both types together represent an area of 400 km² in the Wadden Sea Area and about 300 km² in the nominated Wadden Sea property.

Beaches and dunes

Beaches and coastal dunes together constitute one morphogenetic habitat system. Sand blown by wind in the landward direction from the dry parts of beaches becomes trapped by various pioneer plants. In the Wadden Sea, the main dune generating species is the marram grass *Ammophila arenaria.* This is able to grow upwards with the accumulating sand. Marram grass does not, however, fix the sand entirely. Aeolian transport of sand continues, albeit at a lower rate. It may happen that one dune overtops another. In this way, dune heights of 20 m are exceeded. Above that height, wind forces become too strong for marram grass to slow down sand transport, and bare migrant dunes arise. These usually travel from west to east in response to the prevailing wind direction. Migrant dunes may reach the lee side of barrier islands, supplying beaches and tidal flats there with new sand. Ecologically, beaches and dunes are linked to the other habitats, not only by sand transport but in particular by birds, which rely on beaches and dunes as important foraging, nesting and resting habitats.

Beaches and high sands

All beaches in the Wadden Sea are sandy and mostly situated on the North Sea sides of barrier islands. Mainland beaches occur in the Central Wadden Sea near Cuxhaven and at the tip of the Eiderstedt peninsula. While, in the past, these beaches were regarded as dreadful sites, mostly by sailors threatened with becoming beached in the surf, nowadays these beaches are regarded as the most attractive recreational sites and constitute a major basis for regional tourism. Sandy islands like Trischen, Memmert and Rottumerplaat and vast remote high sands, like the Northfrisian "Außensände", Blauort in Dithmarschen and Richel in the Dutch part, form another important part of the sandy habitats in the nominated property.

Sandy beaches are the most dynamic physical systems of the seashore. Wave energy associated with sediment particle size and tidal range are major structuring forces for beach morphology as well as for the composition of the biota dwelling in the sand (Fig. 2.10). The wave-shoaling zone of the beach system extends far into the North Sea, without a distinct seaward boundary. The surf zone begins with shore-parallel bars and is recognizable from the shore as the breakpoint belt of the approaching waves. Bars are followed by a wide trough until waves dissipate the rest of their energy in the swash zone. This is also called the beach face and is approximately equivalent to the intertidal zone. It often ends in a distinct berm or continues into an extended beach plain

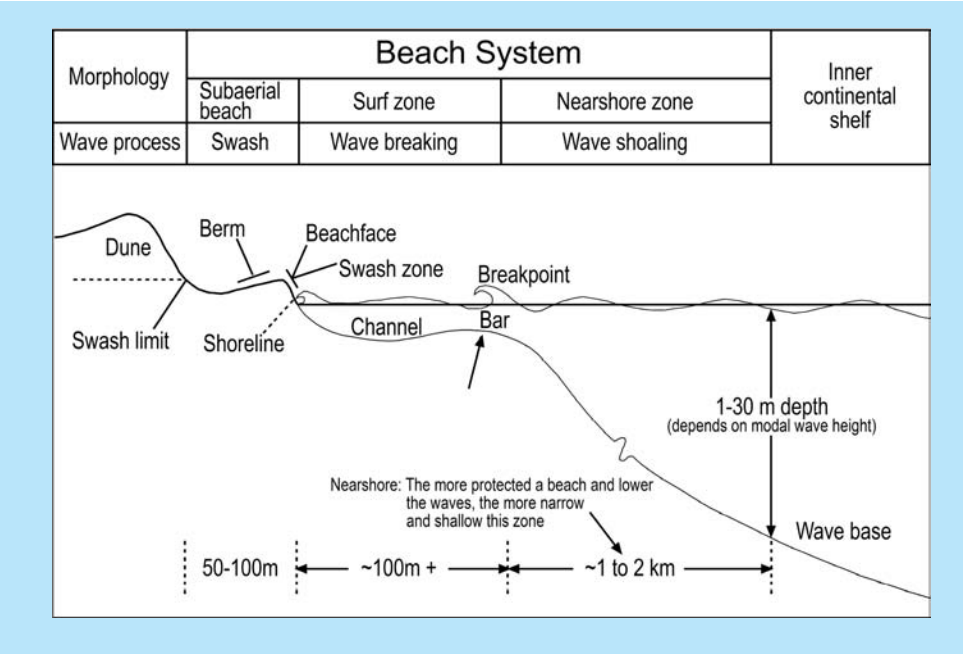


Figure 2.10:
The beach system (source: I. Menn, 2001).

which only becomes part of the swash zone during heavy storms, when waves reach up to the foot of the dunes.

Three beach types are well represented in the Wadden Sea. *Dissipative beaches* represent the high energy end of the beach spectrum. They are a product of large waves moving over fine sand, resulting in a flat beach face and wide surf zone. Dissipative beaches tend to have relatively stable morphologies, and exhibit minimal shoreline change. They are the prevailing type in the Southern Wadden Sea. The low energy end of the spectrum is represented by *reflective beaches*. They develop under combinations of low waves and/or longer wave periods or coarse sand. Reflective beaches have a relatively narrow swash zone and a surf zone is absent. Waves move unbroken to the shore, where they collapse or surge up a steep beach face. Sand is transported shoreward under such conditions and often beach cusps arise. In the Wadden Sea, reflective beaches are not common and are found mostly at the bended tips of barrier islands.

Intermediate beaches represent a transition from high energy dissipative to low energy reflective beaches. They occur under a wide range of conditions, from moderate to high waves, fine to medium sand, and longer wave periods. There is a pronounced long-shore variability caused by alternating rip and bar topography. Intermediate beaches are the most mobile in terms of sediment exchange.

Beach organisms are almost all of marine evolutionary origin. Their distribution is largely physically controlled. Wave exposure has a strong adverse effect on the benthic macrofauna, which increases in abundance and diversity from reflective to dissipative shores. The smaller and highly diverse interstitial fauna of sandy beaches (micro- and meiofauna) thrives best at intermediate beaches. These organisms are somewhat buffered against the physical extremes of the beach environment by dwelling well below the surface during the entire tidal cycle.

The most common macrofaunal inhabitant of sandy beaches in the Wadden Sea is the polychaete worm, *Scolelepis squamata*. It looks greenish, gets up to 8 cm long and has two tentacles to feed on suspended as well as deposited food particles. Together with some amphipods, this worm is the principal prey of sanderlings (*Calidris alba)* which patrol the beaches. This small wading bird runs with an amazing speed in front of splashing waves and is very common from late summer to spring. Its plumage is then black and white, while it is brownish when in its Arctic breeding grounds. Gulls often assemble in huge flocks on beaches, particularly after storm tides, when bottom animals became whirled up in the breaker zone and washed onto the beach face. When the sea is calm, terns often patrol the surf zone in search of small fish.

Interestingly, the numerous interstitial fauna of sandy beaches is barely linked to larger organisms

in the food web. At the base of their small food web are organic imports pumped into the permeable sand by the waves and also some microalgae attached to sand grains. These are exploited by interstitial scavengers and herbivores which in turn are predated by carnivores of similar small body size. Dominant among these is the turbellarian worm *Notocaryoplanella glandulosa* (Otoplanidae). It is a few millimetres long, transparent, and dashes through the interstices of sand. It is capable of adhering firmly to sand grains and also letting loose again very quickly. This helps it to stay within the turbulent zone at the lower beach face of exposed shores.

Several species of air-breathing sand hoppers (talitrid amphipod crustaceans) dwell in the dry sand above the reach of splashing waves near the drift line. They are often superabundant and scavenge mainly at night on organic debris washed ashore. On some beach plains, a very peculiar assemblage of microbiota has developed. This has been termed *colored sand* and shows four distinct layers, of which the upper three measure only a few millimetres in thickness. The sediment surface layer is brownish and contains diatoms (microalgae of the Bacillariophyceae). Below this is a layer of bluegreen "algae" (Cyanobacteria) followed by a layer of purple bacteria. All three perform photosynthesis, and the latter splits hydrogen sulfide as electron acceptor instead of water. These layers are on top of a deep black zone where sulfur bacteria abound. Such *colored sands* have been described from the beach plains of the islands of Amrum and Mellum and from mainland beaches at St. Peter Ording.

Two red-list bird species prefer to nest on plains of dissipative beaches and among cusps of reflective beaches: Kentish plover (*Charadrius alexandrinus*) and Little tern (*Sterna albifrons*). Their survival is threatened because they unfortunately prefer the same beaches as nesting sites that are most attractive for recreation. In winter, snow buntings (*Plectrophenax nivalis*) are common visitors of the upper washlines.

To conclude, there is a considerable extent and diversity of sandy beaches in the Wadden Sea area. The biota are distinctly different in composition from those of the offshore belt and the tidal area. Beaches considerably contribute to overall faunal diversity with rather unique forms of life. In contrast to tidal flats, organisms have little effects on their habitat. Physical factors select the forms of life, most of which are rather small.

Dunes

Coastal dunes develop where sand is mobilized at dry beaches and blown landwards. The sand is trapped by plants, which give rise to a succession of dunes from embryonic to white, grey and brown dunes. This dry dune vegetation (*xerosere*) alternates with wet dune vegetation (*hygrosere*) in the dune valleys (slacks). With a few exceptions (e.g. Eiderstedt peninsula) the dune habitat is confined to the Wadden Sea barrier islands. Dry dune vegetation dominates with 85% over wet dune slack vegetation types (Table 2.3). The dunes included in the nominated property predominantly occur on the Eastfrisian islands and at some confined mainland sites.

Dune succession commences with embryonic dunes and occasionally even starts from a drift line on dry sandy soils. The salt-tolerant *Agropyron junceum* growing slightly above the wet beach face is the most frequent pioneer plant initiating dune formation. Salinity decreases as more sediment becomes accumulated in the shelter of the grass. This is a cumulative effect of rain in the absence of further marine inundations.

Once salinity is low, the vigorously growing marram grass (*Ammophila arenaria)* takes over. It grows upwards with progressive sand accretion and an extensive root system remains in contact with groundwater. Dunes dominated by marram grass are termed white dunes, because bare sand is still visible and is kept in motion by the wind. Vigor of marram grass wanes when dunes mature and lose nutrients. Often, nematodes attack roots and further weaken the marram grass. This allows a diverse group of other grasses, herbs and shrubs to move in. Humus accumulates, and the white sand turns grey (grey dunes) and in later succes-

Table 2.3: Dune vegetation types in a total dune area of about 45 km² in the nominated property (QSR 2004).

Dune types	km²	%
Dry dune vegetation	**38.0**	**85.5**
Embryonic dunes	2.4	5.3
White dunes	7.3	16.5
Dune grassland	17.9	40.2
Dune heath	2.0	4.4
Dune scrub	7.1	16.0
Dune woodland	1.4	3.1
Wet dune vegetation	**6.4**	**14.5**

Embryonic dunes (Photo: Jan van de Kam).

sion brownish, because ferrous hydroxides are released (brown dunes).

Dune grassland prevails in the southern Wadden Sea, while dune heath is more dominant in the north. The dune grassland is facilitated by an atmospheric supply of reactive nitrogen and maintained by rabbits and other grazers. Dune heath is adapted to nutrient-poor conditions. The boreal crowberry *Empetrum nigrum* is considered to represent an end-successional stage, because windy and salty conditions strongly hamper woodland development.

Scrubs often show up on the lee side of white dunes. In the southern Wadden Sea, *Hippophae rhamnoides* dominates where the sandy soils still contain small quantities of lime. This lime dependence is the reason that this scrub can hardly be found on the lime-poor northern islands of the Wadden Sea. Here, the sand willow (*Salix arenaria)* is common. The woodland in the dunes is almost always initiated by plantations, particularly of pine trees.

Between dune ridges, ground water may accumulate and cause moist soil in summer and prolonged inundations in winter. The vegetation in these dune slacks is highly diverse and ranges from pioneer plants, which include many extremely rare species, to fens dominated by grasses or reedbeds. Dune slack heath and willow shrubbery may also occur, as well as occasional dune slack woodlands with low-growing alder and birch.

Habitats in the dunes vary from extremely dry to permanent inundation, from alkaline to acidic, from pure sand to peaty soils, and, finally, from freshwater to rather saline conditions. Dunes dominate the landscape of the barrier islands and provide impressive scenery. However, dunes are also part of the coastal defence system, and for that purpose they have been stabilized in the vicinity of villages and towns. Cliff erosion is often countered by trapping sand with brushwood fences and planting marram grass. In combination with eutrophication, these human interferences have modified habitat proportions with a dominance of dune grassland and scrubs at the expense of embryonic and white dunes.

Besides a rich arthropod fauna, with ants in particular, amphibians and lizards, small mammals and birds populate dunes. Characteristic for moist dune areas are natterjack toads (*Bufo calamita*), which have a yellow vertical stripe on their back. At night, the natterjacks even climb up into the dry dunes to forage on insects there. On islands without foxes, gulls (*Larus argentatus, L. fuscus* and *L. canutus*) maintain large breeding colonies in the dunes. Their import of nutrients from the sea has striking effects on the dune vegetation. Occasionally, eider ducks (*Somateria molissima*) also breed in the dunes. Other breeding birds often encountered in the dune areas are hen harrier (*Circus cyaneus)*, short-eared owl (*Asio flammeus)* and passerines such as wheatear (*Oenanthe oe-*

White dunes
(Photo: Norbert Hecker).

nanthe) and red-backed shrike (*Lanius collurio)*. In late summer whimbrel (*Numenius phaeops*), gulls and starlings forage on berries of the dune shrubs. Hares are widespread, and on some islands rabbits have been introduced. Both modify the vegetation by grazing. Livestock grazing was once common in the dunes but has been phased out.

The lower plant production in dunes than in salt marshes entails less opportunities for animals, which are rather scarce in comparison. On the other hand, plant diversity exceeds that of salt marshes by a factor of ten, including a variety of rare and endangered species. Therefore, almost all of the dune areas in the Wadden Sea are under nature protection. Management measures have been taken to restore successional processes as well as typical species-rich habitats where, in the past, anthropogenic disturbances had modified the vegetation.

Species and population size

Coastal wetlands with their salt marshes, tidal areas, dunes and beaches, belong to the most dynamic habitats on earth. They were tossed forth and back, squeezed and enlarged with the ups and downs of sea level in the past. Terrestrial and limnic organisms are challenged by seawater, while marine organisms are challenged by the vagaries of terrestrial climate. Accordingly, coastal wetlands are not sites where endemic and conservative species could survive and where relicts of the past would encounter a safe refuge.

A naturally high level of disturbances and frequent occurrences of extreme events may even lead to the expectation that biodiversity would be generally low. However, this is not the case in the Wadden Sea. The reason for a high number of species is the manifold opportunities to make a living, at least for some time within a cycle of life. This is because of (1) a high habitat diversity generated by the dynamic transitions between the land and the sea and (2) the rich spectrum of resources washed ashore from the production of the vast oceanic realm, discharged by the rivers from their large watersheds, and made available by the rapid biological turnover on site. In addition, the Wadden Sea is not isolated but in the midst of migration routes and accessible to dispersal along the coast and rivers as well as across the sea.

The following chapter will deal with patterns of species diversity and with populations of sentinel species in the Wadden Sea. It will be shown that incredibly high species numbers have been revealed where this was not expected. The Wadden Sea is a treasure box of extremely specialized species alongside with species of an astounding versatility in their adaptations. The combination of great naturalness with a large areal size offers opportunities for many a species which are endangered elsewhere along the world's coasts (see Tab. 2.5). Particularly when considering the huge flocks of migratory birds in the tidal area, the essential role of the Wadden Sea for global biodiversity becomes obvious. Further, the Wadden Sea is a showcase to demonstrate how important a population of an individual species of organism can be in shaping an entire coast-scape. The

Wadden Sea also constitutes a good example for the reversal of negative trends in populations and habitats brought about by stringent conservation and restoration programs.

Patterns of species diversity

Numbers of species tend to increase with the intensity of an inventory. In the Wadden Sea, there is a long tradition of research on the composition of the regional flora and fauna. Nevertheless, not all groups of very small organisms have been assessed. The Wadden Sea represents a critical habitat for about 2,700 species of marine origin in the intertidal and subtidal zones and at least 5,100 semi-terrestrial and terrestrial species, mostly the flora and fauna of salt marshes and dunes on the islands (Table 2.4). Considering various unicellular groups and small metazoans such as terrestrial nematodes not included in the surveys, we may estimate that the Wadden Sea Area is populated by up to 10,000 taxa of organisms living in the bottom and waters of the sea, in salt marshes, dunes and other habitats on the islands.

Phototrophic plants comprise about 2,300, macrofungi 1,300 and animals at least 4,200 species. With this species richness the Wadden Sea plays an important role in preserving biodiversity in temperate coastal zones in accordance with the requirements of the Convention on Biodiversity. The planktonic species and many of the fish and birds are not residents in the Wadden Sea. They either drift in and out or stay only for some phase of their life or for a particular season in the Wadden Sea. About 800 species belong to this temporary component of the biota. To these, one could add further species which have been observed as rare visitors, stragglers or stray migrants. Also, legions of rare fish and, particularly, birds have been observed. Altogether, these records comprise at least 300 more species not included in Table 2.4.

Complete surveys on species richness within habitats are extremely time consuming and require a wide spectrum of taxonomic expertise. Therefore, this has been rarely accomplished. However, one such an assessment has been performed at a sandy beach with a sand flat on the island of Sylt along a transect from high to low tide level, 115 m long. Altogether, about 50,000 sediment samples have been analyzed and more than one million individuals have been examined and identified to species level. Most species belonged to the interstitial fauna, metazoans small enough to move through the interstices of sand without having to push sand grains out of their way. In total, 652 species were recorded, and for 148 of them that beach is the type locality, because these species were described here for the first time. To these, roughly 200 taxonomic groups not included in the survey have to be added. Also not considered are the plants, of which about 150 unicellular benthic algae may occur at the site. Thus, walking from high to low tide line on that particular beach one trespasses territories of

Marine aquatic organisms	
Vascular plants (seagrass)	2
Macroalgae	80
Pelagic microalgae	380
Benthic microalgae	260
Zooplankton	260
Benthic microfauna	1,200
Benthic macrofauna	400
Fish	149
Marine mammals	3
Terrestrial, semi-terrestrial and freshwater organisms	
Macrofungi (islands)	1,300
Lichens (islands)	347
Mosses (islands)	338
Vascular plants	900
Molluscs	70
Arthropods	2,000
Birds[1]	106
Other vertebrates (mammals, reptiles, amphibians)	40

Table 2.4: Overview on species richness in the Wadden Sea. In some groups numbers have been estimated. Due to taxonomic uncertainties not all species complexes have been analysed, and in terrestrial environments surveys on small soil fauna are incomplete. Rare visitors are left out. (Lists of species encountered in the Wadden Sea Area are compiled in: Wolff W.J. (ed) 1983. Ecology of the Wadden Sea. Balkema, Rotterdam, The Netherlands).

1 This number is listed by the trilateral experts groups Joint Monitoring of Migratory Birds (JMMB) and Joint Monitoring of Breeding Birds (JMBB) based on the EU Birds Directive. 176 species are listed in the framework of the trilateral cooperation, but in total there are many more.

Grazing brent geese (Photo: Klaas Kreuijer).

almost 1,000 species. Macroinvertebrates tend to increase in diversity from high to low tide line and then further with depth of the sea bottom. This is not the case with the diverse interstitial fauna, which attained a maximum of species richness at a 10 m wide terrace just below the steep slope of the beach face. Here, an optimal balance occurs between the supply of organic materials, oxygen availability and water retention during low tide exposure. At this terrace, 350 species per meter interval were found along the transect. Contrary to most larger marine organisms, the hot spot of diversity of the interstitial fauna lies in the intertidal zone rather than at greater depths. The same applies to the benthic diatom algae.

In salt marshes there is an incredible richness of small arthropod species, mainly insects and spiders. The main primary producers, the vascular plants, comprise only 45 species. The microflora was not assessed. Directly feeding on these plants were 6 species of waterfowl and 400 insect species. Another 500 species have been found to feed on dead plant material, algae and fungi. Predaceous arthropods comprised 245 species and parasites 290. To this spectrum we may add about 100 species of birds feeding and resting in salt marshes. The sum of all these species is almost 1,600. Further, to these terrestrial or semi-terrestrial organisms some 500 species of aquatic, mostly marine, invertebrates of the meiofauna have to be added. Again, considering unicellular organisms not included in the surveys, the grand total is probably in the order of 2,300 taxa which dwell in the salt marshes of the Wadden Sea. This number compares well with the richness of species encountered in European temperate forests.

Populations of sentinel species

Birds

The Wadden Sea, with its diverse and often undisturbed habitats and vast tidal flats that serve as feeding grounds, is of an outstanding, international importance for birds breeding, staging, moulting and wintering in the area. A list of breeding, migratory and offshore birds is in **Annex 05**.

The availability of food and a low level of disturbance are essential factors. For 43 species, the Wadden Sea supports more than 1% of the flyway populations, which is the criterion of the Ramsar Convention as an internationally recognized measure for identifying wetlands of international importance. Of these, 4 are breeding birds, 24 are breeding as well as migratory species and 15 use the Wadden Sea only during their seasonal migrations. Of all migratory birds, 29 species occur with more than 10% of their flyway population in the Wadden Sea.

A regular census is carried out on 31 breeding bird species that are considered characteristic for the Wadden Sea and which are indicative of favourable food availability and natural breeding success. In 2001 the survey recorded an overall number of 469,000 breeding pairs or territories. Nearly 70% of the breeding bird population is represented by gulls, with Black-headed Gull

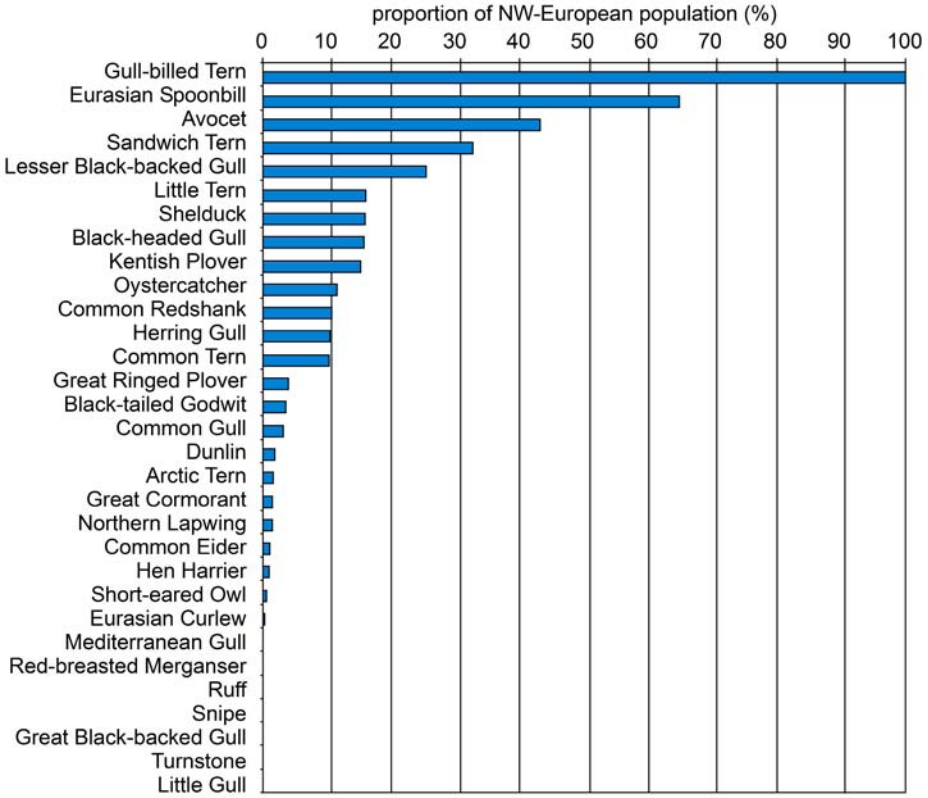


Figure 2.11: Comparison of breeding bird populations in the Wadden Sea in 2001 with NW-European population sizes (from: Koffijberg et al. 2006).

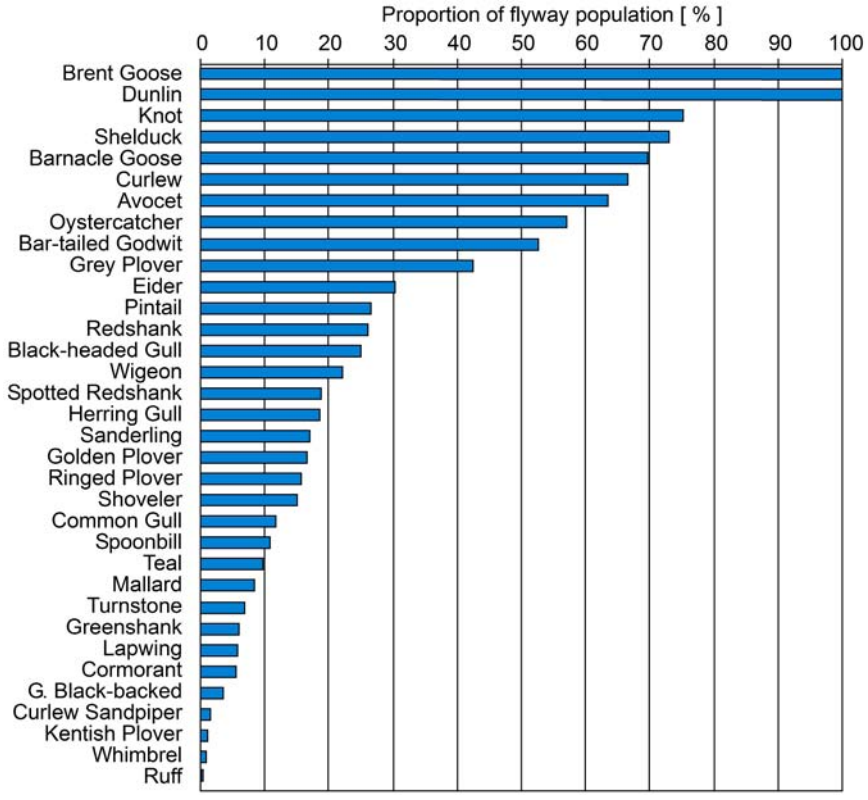


Figure 2.12: Maximum estimated numbers of migratory birds between 1992–2000 given as proportion of flyway populations for the entire Wadden Sea (from: Blew & Südbeck 2005).

Dunlins
(Photo: Jan van de Kam).

(*Larus ridibundus)*, Lesser Black-backed Gull (*Larus fuscus)* and Herring Gull (*Larus argentatus)* being the most abundant species. Another 18% of the total population are coastal waders, notably Oystercatcher (*Haematopus ostralegus(*, Avocet (*Recurvirostra avosetta)*, Northern Lapwing (*Venellus vanellus)* and Common Redshank (*Tringa totanus)*. Among the rare breeding birds are Dunlin (*Calidris alpina schinzii)* and Ruff (*Philomachus pugnax)*, which have been subject to long-term declines and currently balance at the verge of extinction in the Wadden Sea.

In five species, at least 25% of north-western European populations breed in the Wadden Sea. For 21 out of 31 species, the population in the Wadden Sea Area accounts for more than 1% of the NW-European population. In an international context, the Wadden Sea represents a core breeding area for Eurasian spoonbill (*Platelea leucorodia*), Avocet, Gull-billed Tern *(Gelochelidon nilotica)* and Sandwich Tern (*Sterna sandvichensis)*, each supporting between 33 to 100% of the NW-European population.

Breeding habitats are present in salt marshes, dunes, pastures and on beaches. Many species (21 out of 30) prefer islands as breeding sites. This especially applies to colonial breeders like Great Cormorant (*Phalacrocorax carbo)*, Eurasian spoonbills, gulls and terns as well as Hen Harrier (*Circus cyaneus)* and Short-eared Owl (*Asio flammeus)*. Occurrence of the latter two species is mainly in the dune areas in the western Wadden Sea. Populations of Avocet, Great Ringed Plover (*Charadrius hiaticula)*, Kentish Plover (*Charadrius alexandrinus)*, Gull-billed Tern, Northern Lapwing and Black-tailed Godwit (*Limosa limosa)* mainly concentrate along the mainland coast. The Wadden Sea also constitutes a refuge for those species that have largely lost their inland habitats, e.g. Northern Lapwing, Redshank and Black-headed Gull.

Even more important than for breeding birds, is the role of the Wadden Sea as an outstanding internationally important staging, moulting and wintering area. Following the 1% criterion of the Ramsar-Convention, the Wadden Sea accommodates at least 52 such populations of 41 migratory waterbird species that use the East Atlantic flyway and originate from breeding populations as far away as northern Siberia or Northeast Canada. Some species comprise two or more populations which occupy separate breeding regions and also differ in flyways and their timing of migrations. In about 20 populations more than half of the individuals utilize the Wadden Sea at some stage of their annual life cycle. For about 10 species almost the entire populations occur in the Wadden Sea. Numbers of 44 populations of 34 species are so high that the Wadden Sea can be considered as their indispensable and often main stepping stone during migration, or as their primary wintering or moulting habitat. Therefore the Wadden Sea can be considered essential for the existence of these bird species. A severe deterioration of the Wadden Sea would cause a biodiversity loss on a worldwide scale.

Adding up the numbers from a survey in 2000, a maximum of some 6.1 million birds present in the Wadden Sea is obtained. Considering turnover, as many as 10-12 million birds pass through

Bird flock
(Photo: Jan van de Kam).

the Wadden Sea Area each year. This is at least ten times as many as there are coastal breeding birds in the area. Of all migratory birds, waders comprise 55%, ducks and geese 27% and gulls 16%. Most species reach their highest numbers during the autumn migration. Numbers of waders are almost as high during spring, whereas ducks and geese over-winter in high numbers. Only gulls reach considerable numbers in summer. Almost the entire population of the Dark-bellied Brent Goose (*Branta b. bernicla*) and the entire West-European population of Dunlin (*Calidris alpina*) use the Wadden Sea during periods of the annual cycle. Without the Wadden Sea, their populations would suffer heavily. An additional seven species are present with more than 50% and further 14 species with more than 10% of their flyway population.

The Wadden Sea serves as a refuelling region for birds either breeding in Arctic North America or in Arctic Asia. Two subspecies of Knot (*Calidris canutus)* probably split about 10,000 years ago. One breeds in Greenland and Canada and winters in the Wadden Sea. The birds leave for breeding by the beginning of May. Adults begin to return in July and are followed by their young in August and September. This population comprises about 450,000 knots. The other subspecies, probably comprising 340,000 knots, breeds in Siberia and winters in West Africa. These birds only make short stopovers in the Wadden Sea. In spring they arrive after the other subspecies has left, while in late summer and autumn both overlap in the Wadden Sea. All feed on small bivalves buried in the sediments of the tidal flats.

Wadden Sea areas, including the coastal zone of the adjacent North Sea, are used by high numbers of moulting Shelduck (*Tadorna tadorna*) and moulting and wintering Eider (*Somateria mollissima*). In summer, nearly 80% of the NW European population of Shelduck gather in the Dithmarschen Wadden Sea north of the mouth of the River Elbe for moulting. They lose their flight feathers, are completely flightless for some weeks and are thus highly dependent on the vast and undisturbed tidal flats.

Without the Wadden Sea, several European bird populations would be endangered or even lost. Although bird migration is a global natural phenomenon that cannot be associated with a single site, the Wadden Sea is a vital and irreplaceable stepping stone that is considered a critically important 'mega-site' for bird migration. It is not just one of several stopover sites on the East-Atlantic flyway, but it is the essential and indispensable stopover.

Marine mammals

Marine mammals regarded as indigenous species in the Wadden Sea are the harbour seal (*Phoca vitulina)*, grey seal (*Halichoerus grypus)*, and harbour porpoise (*Phocoena phocoena)*. After centuries of hunting, protection measures have fostered a striking comeback in the seal populations. At present, seals are so abundant in the Wadden Sea and flight distance has decreased so much since the ban of hunting in the 1970s that all visitors to the Wadden Sea have a fair chance observing these animals. Seal tours are announced at every harbour and constitute one of the prime attractions for tourists. Off the island of Sylt, also

Harbour seal
(Photo: Martin Stock).

the harbour porpoise became so frequent that encounters on arranged boat tours and regular ferry tours are almost certain when the sea is calm.

The Wadden Sea now sustains approximately 20% of the world-population of harbour seals that belong to the Northeast-Atlantic subspecies *Phoca vitulina vitulina*. Simultaneous counts are performed from the air during low tide in August (moulting season), when approximately two thirds of the seals lie on the exposed sand bars. In total, 15,426 were counted in 2006, compared to about 4,000 thirty years earlier. The increase since then was not an uninterrupted one. A virus disease strongly affected the entire population of the North Sea in 1988 and again in 2002 but recovery seems to have proceeded well. In the Wadden Sea, seals have adapted to the tidal conditions, which regularly submerge their resting and whelping sites. For whelping, females prefer sand flats in the sheltered inner part of the tidal area, while the main sites for resting are sand bars in the ebb tidal delta, from where seals may go hunting either way, into the tidal area or into the offshore belt and further out into the North Sea. Long-term field

Harbour seals resting on a sandbank
(Photo: Klaas Kreuijer).

and pathological investigations indicate that there has been an improvement in their health condition over the last twenty years.

Archaeological findings suggest that grey seals were the dominant species in the Wadden Sea until medieval times. Whelping in this larger seal species occurs in winter when storm surges are most frequent. Therefore, females often have their pups on the upper beaches of the islands. This habit probably made them so vulnerable to hunting that grey seals remained absent from the Wadden Sea for several centuries. Three decades ago, however, grey seals started to re-establish in the Wadden Sea. Thriving colonies are now found in the western Dutch Wadden Sea, in the southern Wadden Sea at the tips of the western Eastfriesian islands, in the northern Wadden Sea off the islands of Amrum and Sylt, and just outside the Wadden Sea a colony became established near the island of Helgoland. Simultaneous aerial counts carried out in March-April during moulting came up with 2,139 grey seals in the Wadden Sea Area. Results from a few recently satellite-tagged animals indicate migration of grey seals from the Wadden Sea to British coasts and vice-versa. Therefore, the rookeries in the Wadden Sea seem to belong to a population which occupies the entire North Sea region.

This also applies to the harbour porpoise. The total population in the North Sea may comprise about 230,000 individuals. Particularly females with small offspring are observed off the northern Wadden Sea. There, aerial surveys in May-August have spotted a mean density of 1-2 harbour porpoises per km². A whale sanctuary was established off Sylt and Amrum in 1999 and is part of the nominated property.

Fish

More than 140 species of fish have been recorded from the Wadden Sea. A list of fish species is in **Annex 04**. Most of them are North Sea or even oceanic species which visit the Wadden Sea but do not depend on this area. Whiting (*Merlangius merlangus)* and Cod (*Gadus morrhua)* have open sea nurseries but in late summer and autumn juveniles may invade the Wadden Sea in huge numbers. Their appearances are highly variable from year to year, and when they occur, they turn out to be very effective predators on Brown Shrimp (*Crangon crangon),* causing its population to crash intermittently. Almost all small fish are also victims of these occasional juvenile incursions.

Other species use the Wadden Sea only as a passage during their migration from the sea to the rivers. These are known as diadromous species. Of those which spawn upstream in the rivers, notable species are River Lamprey (*Lampetra fluviatilis),* Sea Lamprey (*Petromyzon marinus),* Allis Shad *(Alosa alosa)* and Houting *(Coregonus oxyrinchus).* Formerly important were also Sturgeon (*Acipenser sturio)* and Salmon (*Salmo salar).* These have been over-fished and their riverine habitat degraded, but reintroduction and recovery seems possible if their riverine habitats continue to improve. Twaid Shad (*Alosa fallax)*, Smelt (*Osmerus eperlanus)* and Sea Trout (*Salmo trutta)* spawn in the rivers, but

Plaice (Photo: Imke Zwoch).

juveniles and adults tend to live permanently in the Wadden Sea and not merely pass through.

Eel (*Anguilla anguilla)* is also a diadromous fish, albeit the other way round. Eels spawn in oceanic waters, and the pelagic larvae are transported to the coast by Atlantic currents. The larvae metamorphose into transparent 'glass eels' and migrate into freshwater where they spend 6-20 years before the onset of maturation, at which they return to the sea as 'silver eels' and pass through the Wadden Sea in summer and autumn. Some juveniles do not migrate into freshwater but stay in the Wadden Sea until they mature.

For fish in the North Sea, the most important function of the tidal area of the Wadden Sea is that of a nursery. Some of these North Sea fish occur only as juveniles in the Wadden Sea, most notably the flatfish Plaice (*Pleuronectes platessa),* Sole (*Solea solea)*, Herring (*Clupea harengus)* and Sprat (*Sprattus sprattus).* The two flatfish spawn in the North Sea and their pelagic eggs and larvae drift into the tidal area with the currents. After entering the Wadden Sea, the pelagic larvae undergo metamorphosis and settle on the mud flats. Here, they benefit from ample food and warm temperatures. They leave the Wadden Sea as juveniles before their first winter. A part of the juvenile population re-enters the Wadden Sea in its second year, while adults stay permanently in offshore waters. Herring and Sprat are the most abundant pelagic fish species in the Wadden Sea. Juveniles of both species occur side by side, measure 5 to 10 cm in length, and form big shoals particularly at night.

Opposite to the above, Flounder (*Pleuronectes flesus)*, Five-bearded Rockling (*Mustela ciliata)* and Sand Goby (*Pomatoschistus minutus)* spawn in the North Sea and stay as adults in the Wadden Sea. About twenty species are residents in the Wadden Sea and may only leave the tidal area during exceptionally cold winters or, in the case of the Lumpsucker (*Cyclopterus lumpus),* also leave in summer. Eelpout (*Zoarces viviparus)* and Bull Rout (*Myxocephalus scorpius)* both are common demersal fish in the Wadden Sea and stay there during their whole life. Eelpout give birth to fully developed young and males of Bull Rout guard their eggs deposited under shelter at the bottom. The pelagic Garfish (*Belone belone)* attaches its eggs equipped with long sticky hairs to the blades of eelgrass.

Fish are sensitive indicators of a recent warming trend. Species once rare have become residents such as Mullet (*Chelon labrosus*), Anchovy (*Engraulis encrasicolus*), Sand-Smelt (*Atherina presbyter)* and Red Mullet (*Mullus surmuletus).* In general, the finfish fauna of the present Wadden Sea is strongly dominated by small-sized fish.

Macrozoobenthos

The benthic macrofauna of the Wadden Sea comprises about 400 species, of which some 150 occur in the intertidal zone. Benthic macrofauna is less diverse than benthic meiofauna, which counts about 1,200 species. The average biomass of benthic macrofauna on the tidal flats ranges between 38 and 65 g dry organic matter per m², whereas in the inner estuaries and in the North Sea average macrobenthic biomass is much lower (1 - 13 g per

Plumose anemone (Photo: Martin Stock).

m²). Within the tidal area, biomass is low on deep and exposed sandy bottoms and high in mixed and muddy sediments. However, the absolute hot spot is observed in the mussel beds, where biomass ranges between 1,000 to 2,000 g per m². These biomass values are important, because benthic macrofauna is the main food source for most of the birds and fish in the Wadden Sea.

Dominant in biomass are usually the bivalves, cockles (*Cerastoderma edule)* and mussels (*Mytilus edulis)* in particular. Next in biomass are often the worms with the lugworm (*Arenicola marina)* contributing most. Extremely numerous but less important in terms of biomass are the mud snail (*Hydrobia ulvae)* and the mud shrimp (*Corophium volutator)*.

The European cockle (*Cerastoderma edule)* ranges from Norway to Morocco, but its largest population is found in the Wadden Sea. The occurrence of cockles on the tidal flats is rather patchy. Dense patches develop only at times and sites where their main predators, shorecrabs (*Carcinus maenas)* and brown shrimp (*Crangon crangon),* have not encountered the spat in summer. In autumn, also flocks of knots (*Calidris canutus)* can eliminate patches of young cockles. Once reaching a large size, cockles may attain considerable longevity. Individuals up to 15 years of age have been found, and these old ones significantly contribute to the reproductive potential of the entire cockle population. A rare sister species, the lagoon cockle (*Cerastoderma glaucum)*, occurs fairly isolated in salt marsh creeks of the Wadden Sea islands. Presumably, the young attach to birds for dispersal to creeks on other islands, which may explain their genetic homogeneity over wide distances.

The most popular creature for visitors participating on guided walks across the tidal flats are the ubiquitous lugworms because of their highly characteristic coiled faecal strings. These mounds are scattered all over the flats with about 20 to 40 per m². In total, there are roughly one billion lugworms in the entire Wadden Sea consuming sand and digesting adhering bacteria and microalgae. Worms themselves are prey to flatfish and waders. Because lugworms dwell deep in their burrows, predators only get them when worms approach the sediment surface with their rear end to defecate. Tail ends are then sacrificed to the predators and the worms subsequently regenerate.

Lugworms spawn in late summer. Their larvae develop in the mother burrow and then drift into the subtidal zone, where juveniles hibernate among shell debris. In spring, the little worms drift back into the tidal zone and tend to settle at the margins of the adult population, usually as a nursery belt in the uppermost intertidal zone. From there, juveniles gradually migrate in autumn into the area of the adults. This complicated pattern has probably evolved because the sediment turnover caused by a dense population of adult worms inhibits juvenile development. The population size of these lugworms is remarkably stable over the years, perhaps because of this density-dependent response of juveniles to the dominating adults.

Juveniles of brown shrimp (*Crangon crangon)* often take refuge in the feeding funnels of lugworm burrows during low tide exposure. When the tide is in, the shrimp feed on small zoobenthos of any kind and exert particularly high predation pressure on bivalve spat. In effect, successful recruitment in cockles is often confined to years with low shrimp abundance. For the Wadden Sea, it is even the rule that successful bivalve recruitment is limited to summers after a severe winter, because that retards the development of shrimp and crabs. Shrimp spawn in the offshore belt and their larvae are transported into the tidal area by the currents. Juveniles first stay on tidal flats but when their length exceeds one centimetre they begin migrating back and forth with the tides. Most adults stay in the subtidal zone and finally return to the offshore belt of the Wadden Sea.

Plants

Ecologically, the most important plants for the food web of the Wadden Sea are the unicellular algae on the sediment surface and in the tidal waters. More conspicuous, however, are the vascular or flowering plants. In the intertidal zone, two seagrass species, *Zostera noltii* and *Z. marina*, are the major habitat forming plants.

The most characteristic and peculiar plants of salt marsh pioneers in the upper intertidal and lower supratidal zones belong to the glasswort species complex (*Salicornia* spp.). This is a cosmopolitan genus in seashore environments. The succulent halophytes, with their segmented shoots, somewhat resemble a desert plant but are, in fact, growing where they become submerged by the tides twice daily. Seeds germinate at high salinities. In the Wadden Sea, the *Salicornia* species are annual herbs less than 20 cm tall. Most seaward on mud and sand flats grows the upright and slender *Salicornia stricta* (syn. S. dolichostachya). Seeds are not shed and remain on the decaying green plant in autumn. A pioneer on flat sandy beaches is the mostly low-growing *Salicornia procumbens* (syn. *S. decumbens*), which turns from green to yellow and orange in autumn. More within the salt marshes in between other vegetation grows

Sea holly
(Photo: Jan Huneman).

Salicornia brachystachya (syn. *S. ramosissima*). Its seeds even germinate at shaded sites, which is not the case in the other species. This strongly branched plant tends to have rather short shoot segments and turns from green to dark red in autumn. Taxonomists disagree about the proper subdivision of this complex of species. Speciation is still ongoing in the Wadden Sea and has not yet become genetically entrenched, and each species exhibits a high plasticity in its growth form. There is a strong tendency to inbreed and distinctive local populations may occupy contrasting habitats. The Salicornia species have attracted much research, because glassworts were seen as useful pioneers for the purpose of converting tidal flats into salt marshes, which then could be claimed and transformed into arable land. This interest is gone but glassworts are still highly regarded as a tasty vegetable.

Glassworts were the only salt marsh pioneers on tidal flats in the Wadden Sea until eighty years ago. Then, cord grass was introduced to facilitate sediment accretion at the shore. It originated from a hybrid between the Afro-European *Spartina maritima* and the American *S. alterniflora*, accidentally introduced to southern England. The sterile hybrid converted by autogenic chromosome doubling into a fertile species, which has been named *Spartina anglica*. Coincidentally, that happened very close to the site and time of Darwin writing on the origin of species. This vigorous species now dominates in the pioneer zone of salt marshes in the Wadden Sea. With glassworts and cord grass, the species diversity in the pioneer zone is rather low but rapidly increases in a dynamic mosaic-like fashion further up in the supratidal zone. Here, the Wadden Sea salt marshes in summer display a picturesque sea of flowers which is one of the main attractors for people visiting this coast.

The low marsh, inundated by more than one hundred floods per year, is characterized by a low-growing grass, *Puccinellia maritima*, often in combination with the purple-flowering *Limonium vulgare*. On clayish or brackish ungrazed marshes, *Aster tripolium* can be present. On well-drained creek levees and terraces *Halimione portulacoides* is the dominant species. On the middle marsh, with less than 100 floods per year, a dense lawn of *Festuca rubra* and *Juncus gerardii* is developed, sometimes associated with *Limonium vulgare* and *Artemisia maritima*. Sandy salt marsh pastures often have a pink appearance in early summer, because *Armeria maritima* achieves dominance. It is avoided by livestock. When grazing by domestic animals is reduced or ceases, and depending on geomorphological conditions, clay content and elevation, *Elymus athericus*, *Halimione portulacoides*, *Spartina anglica* or *Elymus repens* can represent the dominant species within the salt marshes. Under brackish conditions, *Phragmites australis* will prevail.

Without the marram grass (*Ammophila arenaria*), the barrier islands of the Wadden Sea would presumably look very different. This can be inferred from observations made at the coast of

Salt sandspurry (Photo: Norbert Hecker).

Oregon in Northwest America. After introduction there, the marram grass altered the dynamics of the dune system entirely. It quickly generated a high and permanent fore-dune barrier behind the beach where none had been before. Sand formerly blown further inland was now trapped, and on the leeside of the new dune ridge a wet deflation plain emerged with unstable 'quicksand'. Thus, a coastal landscape which had existed for 10,000 years was dramatically transformed within a few decades by the introduced marram grass.

In the Wadden Sea, however, marram grass is native. It can cope with sand accretion rates of up to one meter per year by extending its shoots. Sand accumulates because the tussocks substantially slow down the wind speed above ground level. The grass extends horizontally with its rhizomes and its roots penetrate the emerging dune to depths of two meters or even more. Leaf rolling and a thick cuticle on the outer side restrict transpiration losses and reduce damage by sand blasting. Although marram grass only dominates the vegetation on the white dunes, without its dune-building capacity all the later successional phases with the many rare and endangered plant species could not develop. This is a striking example of how the attributes of one particular species of plant have created an entire coastal landscape, and it is hard to imagine what the evolution of the Wadden Sea barrier islands would have been like without marram grass.

Endemic and threatened species

As a coastal wetland, the Wadden Sea is neither sufficiently isolated for the evolution of endemic species nor has it remained climatically stable enough over the past millennia to preserve relict species. In addition, there is a long list of unicellular algae and small-sized invertebrates which have been first described for science from type-localities in the Wadden Sea, and up to now have not or only rarely been recorded elsewhere. However, for these taxa, a lack of records from outside the Wadden Sea is most likely caused by a lack of studies rather than real endemism. A list of endemic saltmarsh species is in **Annex 06**.

The Wadden Sea has remained a coast-scape which still provides ample space and resources to all these populations, and many of the large animals once threatened by man have started

Species	Common name	IUCN Red list status	EU Directive status
Phocoena phocoena	Harbour porpoise	VU A1cd	HD Annex II, V
Alosa alosa	Allis shad	DD	HD Annex II, V
Alosa fallax	Twait shad	DD	HD Annex II, V
Coregonus oxyrinchus	Houting	DD	HD Annex II, IV (priority species)
Lampetra fluviatilis	River lamprey	LR/nt	HD Annex II, V
Limosa limosa	Black-tailed godwit	NT	BD Annex II

Table 2.5: Threatened vertebrate animals on the IUCN Red List with survivors encountered in the Wadden Sea.

to recover during recent decades. Some species threatened in general find refuge in the Wadden Sea to some extent (Table 2.5). However, all of these are migratory and cannot be rescued by measures confined to the Wadden Sea. Particularly, fish cannot take advantage of protection within the Wadden Sea as long as riverine habitats are not sufficient (e.g. for the sturgeon, Acipenser sturio) or fishery pressure continues further offshore (e.g. on thornback skate, Raja clavata).

The Wadden Sea as a gigantic coastal filter system

The Wadden Sea ecosystem represents one of the most important wetland habitats in the entire world. It provides a multitude of transitional zones between land, the sea and freshwater. All of its habitats together function as a gigantic coastal filter system. Water runoff from the land and water masses from the sea are mixed and flushed with the tides several times back and forth before being taken up by the long-shore current and eventually released to the Atlantic Ocean.

Riverine and marine imports of organic matter and dissolved compounds are retained. This clearance operation is mediated by the coastal biota. It begins with life in permeable sands in the offshore belt of the Wadden Sea and extends onto the sandy beaches and tidal flats. Waves push water into the interstices of the sand. These sand grains are highly bioactive, because they are overgrown by films of microorganisms. Some are photosynthetic and enrich the water with oxygen. Others utilize this oxygen to mineralize organic matter. In deeper layers of the sediment, this process proceeds more slowly in the absence of oxygen.

On the sandy tidal flats large burrowing infauna irrigates the sediments and enlarges the oxic remineralising zone by several orders of magnitude. Particularly the abundant lugworms pump down water into the underground, providing a unique habitat for microscopic organisms, with species which do not occur anywhere else. These large burrowers considerably facilitate the biogenic coastal filter function.

Cohesive mud is covered by a living slime full of microscopic algae and bacteria which trap particulate and dissolved matter. Their highly bioactive film further purifies incoming water which has already passed the permeable sands and lugworm flats further seaward. Even inside the salt marshes, films of microbiota cover the sediment surface and contribute to the mineralization of the organic imports from the land and the sea as well as from the bio-production within the salt marsh.

The many suspension feeders in the tidal area are a third component of the coastal filter system. Bivalve molluscs are the prominent members, but filter feeders of many other zoological phyla are involved, such as tentaculated worms or worms which construct a filter out of slime, small crustaceans with feathered setae on their legs, colonies of polyps which grow on shells and algae and many more. Most of these live at the bottom, but some also drift in the tidal waters while filter feeding. It has been calculated that the bivalves alone filter the entire water volume of the Wadden Sea once every two weeks.

Suspension feeders tend to aggregate. Mussels beds are particularly characteristic for the Wadden Sea and significantly reduce suspended matter in the passing water. In return, they release nutrients like ammonia and silicate at a much faster rate than sediment bottoms, thereby facilitating the growth of phytoplankton. This may then drift to other mussel beds, serving there as a renewed food supply. In addition to phytoplankton, re-suspensions of bottom particles including benthic microalgae also may contribute considerably to the food of suspension feeders in the tidal area. Re-suspended matter may amount to almost half of the food supply.

A large part of the planktonic food for suspension feeders comes from the North Sea, where phytoplankton blooms arise in the coastal waters. There, transparency for unhampered phytosynthesis is higher than in the shallow turbid waters laden with re-suspensions from the bottom. Thus, a purification of North Sea waters takes place in the Wadden Sea, effected by the coastal filter system. This filter never clogs, because it is permanently renewed by the consumers within the food web of the Wadden Sea.

Considering birds and fish, the rich populations of benthic suspension and deposit feeding invertebrates in the tidal area constitute a large fuelling station from which birds fly to distant lands and fish swim up the rivers or across oceans. In this respect, the Wadden Sea serves not only as a gigantic filter system but as an equally gigantic import and export system between land and sea as well.

The exceptionality of the Wadden Sea resides in the following qualities:

- Its vast size as an amphibious transition between land and sea;
- A unique diversity and combination of dynamic aquatic, semi-aquatic and terrestrial habitats;

- A diversity of resident organisms together with an extraordinary number of migrants;
- Breathtaking numbers of birds assembling in flocks dancing through the sky;
- Millions of aquatic nurslings exploiting food in comfortable shallow waters;
- A bewildering diversity of tiny organisms specialized on changeable seashore conditions;
- The mastery of outstanding species of plants and animals over the dynamics of their physical environment by creating solid reefs, permeable sediments, sticky mud, accreting salt marshes and high dunes.

Exploitation of natural resources

Gas and oil

All activities related to exploration and exploitation are subject to the strictest regulations probably world wide. They will be carried out in accordance with binding international and national mining and nature protection legislation, and in compliance with the Wadden Sea Plan (Stade Declaration 1997) and international regulations, for example PSSA, OSPAR, AEWA, MARPOL, and the Ramsar and Bonn Conventions.

In Schleswig-Holstein the Wadden Sea Plan is implemented by the National Park Act. Oil exploitation is confined to the existing exploitation site at Mittelplate in the Schleswig-Holstein Wadden Sea. In the Dutch Wadden Sea new exploration and exploitation of gas is only permitted from sites on land and from existing platforms in the North Sea coastal zone outside the nominated property.

An overview of oil and gas production sites and pipelines is given in Figure 2.13.

Gas exploitation in the Netherlands

In the Dutch Wadden Sea there is one site for the exploitation of natural gas: Zuidwal. All other production sites are located outside the nominated property, but the wells or reservoir may extend under it. Not all prospects and leads are yet explored or in production. However, it is agreed that new exploration drilling and new production installations will not be permitted in the future in the Dutch part of the nominated property . As a consequence, new production from under the Wadden Sea will have to be developed from the mainland, the islands or the North Sea coastal zone.

The exploitation of the 'Zuidwal' concession area (Vermilion) in the middle of the western part of the Dutch Wadden Sea near Harlingen concerns a deposit which has been estimated to encompass about 22 billion m^3 of exploitable natural gas. Exploitation started in 1989. The natural gas is transported via pipeline to a treatment installation in Harlingen. All solid wastes from the exploitation site are transported to land and the produced water is returned to the reservoir. The production facility is a 'zero emission unit'.

Adjacent to the nominated property, there is the production site 'Blija Ferwerderadeel' located on the mainland coast in the eastern part of the province of Fryslân and also producing from under the Wadden Sea. More to the east, permits were recently granted for three additional exploitation sites adjacent to the Wadden Sea, Moddergat, Vierhuizen and Lauwersoog, for production of gas under the nominated property. These permits were granted after a comprehensive decision-making process, including a full impact assessment procedure. Production is allowed within the limits of the resilience of the Wadden Sea to compensate sea level rise by natural sedimentation. Gas production within strict permit conditions will not deteriorate the qualities of the Wadden Sea. Both subsidence and the ecological development will be followed by a strict monitoring program. The exploitation has been permitted on the condition that the production will not adversely affect the nominated property.

The Groningen gas field extends slightly under the Wadden Sea and the Ems estuary. All production sites are on the mainland, and no production wells were drilled under the Wadden Sea. A monitoring well to register pressure is situated on a small artificial island in the estuary. The island is a breeding site for a colony of cormorants. New production facilities on the mainland behind the sea dike, are not expected, but cannot be excluded either.

The island of Terschelling is the most western island with a potential for gas development. The expected reserves are small and have not yet been developed. In the present energy situation, there are no plans to do so. The island of Ameland holds the third largest gas field of the Netherlands. On Ameland, three sites were constructed. The site with production was built in 1983 and is situated on the east cape of the island. The site is connected to two offshore platforms (2-3 km offshore at a water depth of 5-10 meters). The morphology and ecology in the area are influenced by the production (subsidence), and this has been monitored since 1987 under supervision of an independent commission. The technical reports are published

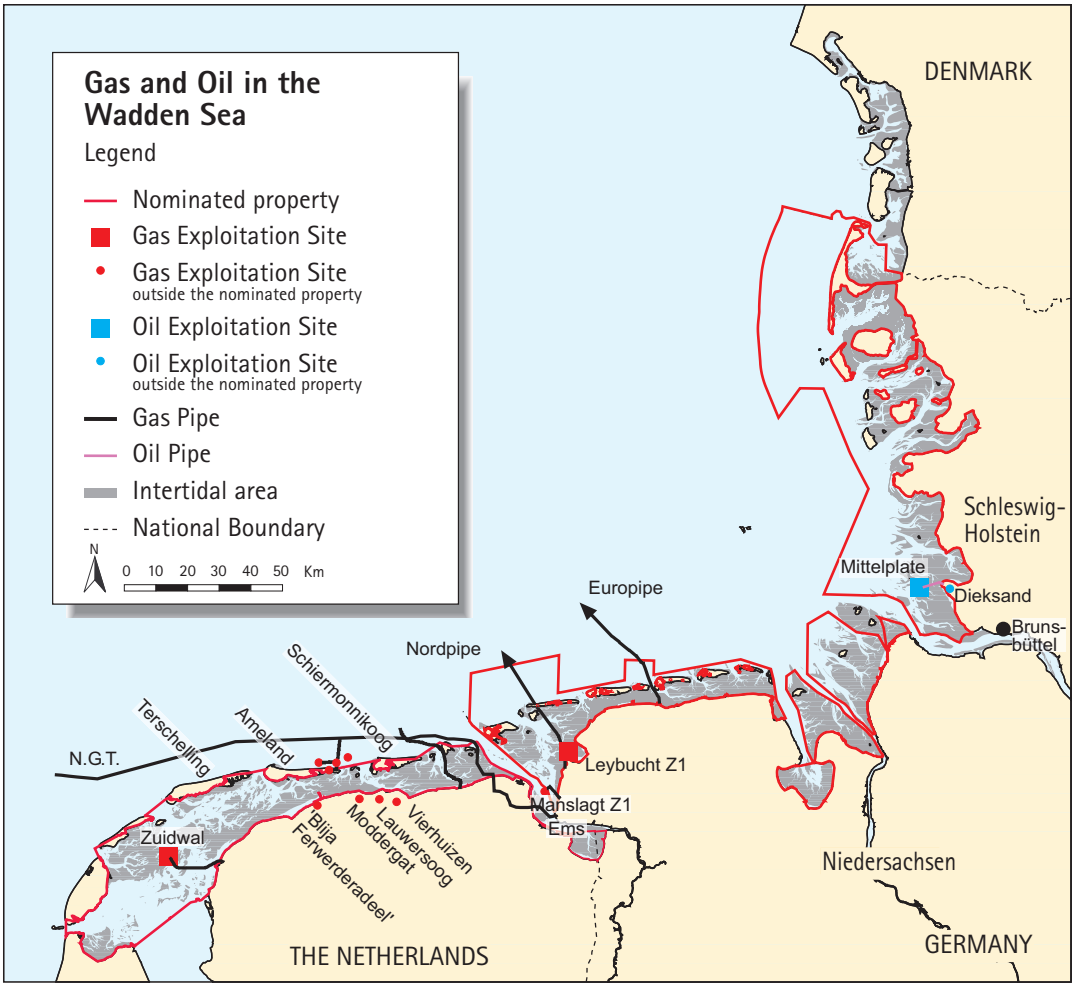


Figure 2.13: Gas and oil in the Wadden Sea (on the basis of the QSR 2004).

about every 5 years in the public domain. Reports are in Dutch, but a summary is available in English and in Russian. The monitoring will continue until the end production in 2020. On the west cape of Ameland near Hollum, an old well site is situated. Reserves have been assessed but have not been produced. On the south side of Ameland (Ballumer Bocht) a future well site was constructed to explore a small prospect partly under the island and partly under the nominated site. Exploration was postponed until a later date, in order not to interfere with the decision-making with respect to Moddergat and Lauwersoog production.

The island of Schiermonnikoog does not hold any reserves to our knowledge, but on the seaside development will continue. Between Ameland and Schiermonnikoog, a so-called monopole is situated, with wells that connect to offshore gas fields. These fields are not yet in production. All these sites and platforms are located outside the Wadden Sea, but the concession area extends over the mainland, the Wadden Sea and parts of the North Sea.

Gas and oil exploitation in Germany

In Germany all exploration and exploitation activities are subject to the Federal Mining Act and are carried out in accordance with the relevant mining regulations procedure. In the context of this licensing procedure, standard authorisation preconditions are required to be fulfilled. The relevant nature protection regulations of the National Park Acts, the State and Federal Nature Protection Acts, relevant EU directives and international regulations are to be complied with and followed.

There are two sites where natural gas is exploited in the Niedersachsen Wadden Sea Area. 'Leybucht Z 1' in the exploitation field 'Juist-Leybucht I"' of the concession area 'Juist' is situated in the nominated property. Production started in 1977. 'Manslagt Z 1', in the exploitation field 'Groothusen II' of the concession area 'Groothusen', is situated in the Ems estuary outside the nominated property. Production started in 1993 and stopped in October 2000 because

of an occlusion of the drill-hole. It is currently being investigated whether production can be resumed.

Oil production only occurs on one location in the nominated property, in the Dithmarschen part of the Wadden Sea near the island of Trischen. Concessions were already issued in the 1950s. The consortium "Mittelplate" started the construction of the exploitation site "Mittelplate A" before the National Park Schleswig-Holstein Wadden Sea was declared in 1985. Oil production started in 1987. In the 1999 amendment of the National Park Act, the permit for oil production within the nominated property was restricted to the existing exploitation site. According to current estimates, there are still more than 100 million tons of crude oil in several layers of oil-bearing sandstone at depths between 2,000 and 3,000 meters. Around 60 million tons are considered to be recoverable, this being the most important oil deposit in Germany.

In 1998, drilling operations started to exploit part of the oil from the eastern section of the 'Mittelplate' field from the mainland. In 2000, onshore production started at the Dieksand land station in Friedrichskoog in order to increase the exploitation and to limit the presence of the existing drilling site in the area. Formerly, the crude oil was transported to Brunsbüttel by three special double hull tankers. In 2003, plans for a pipeline were approved, which went into operation in 2005. Thus, disturbance of moulting Shelducks have been minimized and potential risks of oil spills have been virtually excluded.

Through the full operation period of the 'Mittelplate A', monitoring has been conducted in order to assess the ecological impact of the drilling site. Until now, no negative effects at the locality and its surroundings have been found. The production facility can be characterized as a 'zero emission unit'.

Fishery

The main fisheries in the Wadden Sea are for brown shrimps and blue mussels. There is one license for oyster (*Crassostrea gigas*) culture in Schleswig-Holstein. Additionally there is a local fishery on a limited scale with fixed nets and tow nets.

Shrimp fishery

The shrimp fishery focuses on the offshore belt and deeper subtidal creeks, because this is where the large adults stay while the smaller shrimp populate the tidal area. In former times, the rough surf in the offshore belt confined the shrimp fishery to beam-trawling in the more sheltered back-barrier area, but this limitation has been overcome by larger and better motorized vessels. The data about landings, recorded in each country, do not differentiate between the yield fished in or outside the Wadden Sea Area. The yearly average catch in the total landings of shrimp for the period 1994-2003 was about 21,000 t. Landings are mostly regulated by the capacity of the market. The scenic shrimping vessels with their beams uplifted, visible over a long distance, and followed by flocks of scavenging gulls have become almost an icon for

Shrimp fishery (Photo: Klaas Kreuijer).

Wadden Sea tourism in many parts of the Wadden Sea. Shrimps are a popular delicacy of the region and an economic factor for the coast.

In the Netherlands, 90 vessels are operating in the Wadden Sea. Of these 60 are exclusively fishing on shrimps. The total average annual catch in the Netherlands (including that from vessels outside the Wadden Sea) was about 10,000 t in the period 1994-2003. About half is fished in the Wadden Sea.

In the German part, the shrimp catch has been in average around 11,000 t/yr. In Schleswig-Holstein, 99 vessels (2003) are mainly involved in shrimp fishery. In Niedersachsen, shrimp fishery was carried out by 101 vessels, which were exclusively fishing for shrimps, and an additional 35 vessels, normally fishing flatfish, but which also fished for shrimps in 2003 (in total 136 vessels for shrimp and flatfish fishing in 2003). Shrimp fishery for animal consumption is of minor importance and only carried out in Niedersachsen in the second half of the year. The landings are around 600-1,200 t/yr., which is about 13% of the amount landed for human consumption in Niedersachsen.

Shrimp fishery is allowed in the nominated property with the exception of those areas designated as no-take zones or reference areas in the Schleswig-Holstein and Dutch part.

Blue Mussel fishery

In the Netherlands and Germany, blue mussel fisheries are mainly carried out on seed mussels from natural mussel beds. The seed mussels are then dispersed on culture lots where they grow to marketable size. In Niedersachsen, fishing of wild mussels for direct consumption is only allowed on sub-littoral banks, and only small amounts are being fished (about 200 t in 2002). In the Schleswig-Holstein and Dutch Wadden Sea, commercial fishery of wild mussels for direct consumption is not allowed. Major parts of the Wadden Sea (intertidal and subtidal areas) are closed for blue mussel fisheries. An overview of additional restrictions is given in Table 2.6.

In addition to the regulations already existing for culture lots, new regulations concerning the mussel fishery have been introduced gradually since the mid 1980s to ensure a sustainable mussel fishery in accordance with stated conservation objectives and the trilateral Targets. At the 1991 Wadden Sea Conference in Esbjerg, it was agreed to close substantial areas for mussel fishery. The Wadden Sea Plan continues the policy of closed areas, also with the aim to protect and enhance the growth of wild mussel beds and Zostera fields. Mussel fishery will, in principle, be limited to the subtidal area. Finally, the Wadden Sea Plan stipulates that the current area of mussel culture lots will not be enlarged.

The blue mussel fishery is strongly dependent on natural conditions and the availability of natural spat fall, which is highly variable. Therefore, the catches of mussels show strong fluctuations per year and region. In the last ten-year period, the years 1998 and 1999 allowed higher catches, whereas in 2001 and 2002 the lowest catches were reported. The average annual landings of mussels in the past 10 years (1994-2003) were

Table 2.6: Overview of shellfish fishery and management (from Quality Status Report 2004), (adapted).

	The Netherlands Wadden Sea	Niedersachsen Wadden Sea	Schleswig-Holstein Wadden Sea
Average annual mussel landings (metric tons gross)	26,380 (2001-2005) (from culture lots)	7,278 (94-03) (culture + wild)	16,500 (95-05) (from culture lots)
Mussel culture in area (ha)	Designated: 7,600 used: 3,300	1,300 (maximum)	2,000
Number of licenses	89 (seed fishing vessels), 82 mussel culture	5 (vessels)	8
Quota	For seed mussels	None	None
Permanently closed area (ha)	42,540	93,480	135,000
Additional restrictions	Intertidal: Seed fishery on unstable mussel beds only if at least 2000 ha of 1-year old mussel beds are left.	Additionally 17 sites closed in accordance with Management Plan (about 10% of intertidal mussel beds)[1]	None

1 Average of 5 years (1999-2003). The closed area covers 33.8% of the National Park area.

about 65,000 tons wet weight (including shells), of which most (about 39,000) was landed in the Netherlands. Table 2.6 provides an overview of shellfish fishery in the nominated property.

The majority of landings are traded in the Netherlands. A considerable part of the German landings are transported to the Netherlands for processing and sale.

Due to the lack of reasonable spatfall of blue mussels in the past years, recent experiments are being carried out with new collector methods, and seed mussels are being collected with the help of so-called smart farms. Finally, it should be noted that Spisula fishery (*S. solida* and *S. subtruncata*) is either prohibited or not taking place because of lack of stocks.

Cockle fishery

Since the closure of mechanical cockle fishery in the Dutch part of the nominated property, it is now prohibited in the entire nominated property. The cockle fishery has been phased out in the German part for almost 20 years. A manual cockle fishery is still allowed in the Dutch Wadden Sea, with a maximum yearly catch of 5% of the cockle stock. A maximum of 31 licenses for the manual cockle fishery may be granted. As yet, 17 licenses have been actively used. In 2005, 365 tons of meat were landed. For that year, a quota of 600 tons was fixed. Non-commercial, manual collection of shellfish is also allowed, if this does not exceed a catch of 10 kg a day. Commercial collecting of mussels is not allowed.

Extraction of sand and shells

Sand extraction has a long history as a traditional use of the area. The main purposes were the use of the material for building dikes, dwelling mounds and roads. During the past decades, this activity has steadily declined. Today, still a certain amount of sand is used only for purposes of coastal protection, e.g. beach nourishment, dike and dwelling mound (on the Halligen) reinforcement. In the Dutch part of the nominated property, sand extraction is only allowed as a side product of regular maintenance of shipping lanes, incidental deepening of main shipping lanes or clearance for the sake of construction. Sand extraction for commercial purposes is not allowed in the Niedersachsen Wadden Sea. Sand is only extracted for dredging of shipping lanes and coastal defence purposes. In the Schleswig-Holstein Wadden Sea, no sand is extracted for commercial purposes. In the period 1999-2003, an average of 1.1 million m^3 was extracted per year for coastal defence purposes.

The extraction of shells is only carried out in the Dutch part and has also decreased in the past years. It is regulated by introduction of quotas on extraction and by limitation to three locations: Marsdiep, Vlie and Friese Zeegat, below normal 5 meters. The total allowable amount of shells to be extracted in the Wadden Sea and the adjacent North Sea coast is based on a long term average of the natural calcimass production, of which the extraction of 50% is allowed but with a maximum of 90,000 m^3 in the Dutch Wadden Sea. The extraction of shells in the German Wadden Sea is not allowed.

Hunting

Hunting has been completely phased out within the nominated property with the exception of a restricted hunting on some waterbirds for 10 days and hunting of hare on parts of the inhabited islands in Niedersachsen.

Nonetheless, hunting has a long tradition in the Wadden Sea region. In former times, taking of seals and trapping of waterbirds - mostly geese and ducks – were traditional and integrated parts of the livelihood of the inhabitants of the Wadden Sea isles and the coastal areas. Waterbirds were also hunted to be sold to provide an additional income. Hunting of waterbirds included a selection of ducks, geese and waders, depending on the country involved. The many duck decoys, which still exist along the coast, bear witness to this. Some of these have been restored and serve, amongst others, as museums, whereas others are still functioning. However, methods, equipment and also the purpose changed with time, as has legislation and public opinion on hunting. Nowadays, hunting has changed into a mainly recreational activity, with the exception of hunting of rabbits on behalf of coastal protection. Seals are no longer hunted in the Wadden Sea (closing of the hunting season in the Netherlands in 1962, in Niedersachsen in 1973, in Schleswig-Holstein in 1974). Exemptions for hunting for wildlife management and pest control are possible.

Salt marshes – Land use and management

Mainland salt marshes have been embanked for centuries for land reclamation and coastal protection. Their extent today is only a fraction of the previously widespread transition zone between fresh, brackish and saline habitats. Land reclamation stopped in the 1950s of the last century and the last large embankment for coastal protection ended in the early 1980s. In connection with

coastal protection activities, salt marsh areas have been created in front of the new dikes to maintain their function as wave breakers. These 'artificial' salt marshes have developed since then as semi-natural salt marshes with an ecological function similar to natural salt marshes. Today, in some places in the Netherlands and Niedersachsen "outpoldering" projects are being carried out.

Coastal flooding defence and protection

Through maintenance of the drainage channels and brushwood groins along the mainland coast, almost all the area of foreland-type salt marshes has an oversized creek system and a reduced morphological variation. Salt marsh revetments, mainly as sedimentation fields ("Lahnungsfelder", "landaanwinningswerken") are being maintained to protect the salt marsh edges around the islands, Halligen and the mainland coast from erosion due to the extremely high wave energy. During the last 20 years the artificial drainage system also has been reduced, in many places to a size which is needed to guarantee a safe drainage of the dike after storm surges. In about 39% of the mainland salt marshes, no drainage measures have been taken during the past 10 years. This has enhanced natural sedimentation and erosion processes and the development of natural salt marsh vegetation. In order to gain sod for coastal defence, grazing of the sod areas is necessary.

Grazing

Grazing by domestic animals can interfere with the natural development of salt marshes. Too intensive grazing by cattle or sheep may lead to destruction of the top soil layer and a decrease of the perennial vegetation due to feeding and trampling. It results in a decrease in sedimentation and in reduced soil conditions and soil stability, both of which are harmful for coastal protection and nature conservation. It leads to a monotonous habitat structure and, in this way, to less attractive conditions for breeding birds. Low-rate grazing, on the other hand, can possibly increase the diversity of plant and animal species on sites with a clay layer thicker than 15-20 cm.

In former times, many sites were intensively used for agricultural purposes. Since the mid 1980s, a reduction of areas with intensive grazing by 50% could be observed on the mainland salt marshes in the Netherlands and Germany (Figure 4.3). In some case, moderate grazing is carried out for biodiversity purpose. Many areas with natural and semi-natural salt marshes have developed during these last two decades.

On the islands, the majority of the salt marshes can develop naturally, and they show various transition stages. Livestock grazing for agricultural purposes has generally decreased in all areas during the past 20 years. In about 60% of the salt marshes there were no drainage measures taken at all, and in an additional 31% no artificial drainage measures have been carried out during the past 10 years.

2.b History and development: A Wadden Sea of change

Coastal wetlands all over the world changed considerably in position, size and shape in the wake of a postglacial sea level rise of more than one hundred meters over the last 16,000 years. Hunters and gatherers frequented these bountiful coasts from the beginning. Severe resource depletion commenced in Asian and Mediterranean regions 2,500 years ago. In the North Sea region, intensification of resource use began about a thousand years ago. Human impacts intensified with population growth and dominance of global markets but then slowed in some and reversed in a few coastal wetlands, including the Wadden Sea, by prudent environmental management. In this section, the geomorphological, human and ecological history of the North Sea region with the Wadden Sea at its centre is summarized, concluding with perspectives on future developments.

Early geomorphological development

Since the end of the last glaciation, sea level has risen by 120 m in the North Sea region (Fig. 2.14). During a fast rise until 7000 BP, tundra and boreal forest in the southern North Sea were inundated. When the shoreline approached the region of the present Wadden Sea, sea level rise decelerated. Some phases of stasis or fall occurred intermittently. A switch from transgression to 200 years of regression took place around the beginning of the Christian calendar. This interval was followed by a rise of roughly 2 m until today.

When sea level rise slowed down, barrier spits with sand dunes developed. These were eventually breached and cut into barrier islands as sea level continued to rise and tidal range increased. In the southern part, this happened between 7500 and 6000 BP and constituted the birth of a coastal configuration which resembled the present Wadden Sea. The tidal area behind barrier islands gradually enlarged with sea level rise. When this stopped intermittently, the tidal area decreased, and then increased again when sea level rise continued. Landward of the tidal area,

a marsh of a similar areal extent provided a wide episodically flooded plain, consisting of salt marsh vegetation and brackish to limnic reed marshes. Between these marshes and the Pleistocene elevations, extensive raised bogs developed. Along major rivers, gallery forests occurred at the levees. Otherwise, the marsh was a treeless plain kept open by episodic flooding.

Such a coastal landscape may be regarded as a pristine condition of the Wadden Sea, and it lasted until about a thousand years ago. The positions of shorelines at islands and between the tidal area and the salt marsh area were highly dynamic and shifted back and forth with sea level and sediment supply.

Human history

As far as we know, humans have always been present in the Wadden Sea region. Islands, tidal flats and marshes, with a diversity of fish, shellfish, fowl, mammals and wild plants must have offered ample opportunities for Neolithic and Mesolithic hunters and gatherers. The archaeological evidence is scarce, however, as traces have been destroyed by wave erosion or buried under massive layers of sediments. Permanent settlement was largely restricted to higher grounds. On the moraine islands of Sylt, Föhr and Amrum, outside the nominated property, as many as 77 megalithic graves and 1000 Bronze Age barrows have been located, and the adjoining tidal flats and sand dunes provided dozens of flint daggers and sickles.

Wetland settlements are known from the western part of the Wadden Sea from 5500 BP onwards. Fishing and fowling was combined with agriculture. About 3350 BP, relatively large numbers of colonists settled at a former salt marsh estuary on the Noord-Holland peninsula and, later, on the banks of the rivers Weser, Elbe and Ems. Settlements were abandoned when extending bogs and recurrent sea-breaches submerged the farmland. Settlers on the seaward salt marshes

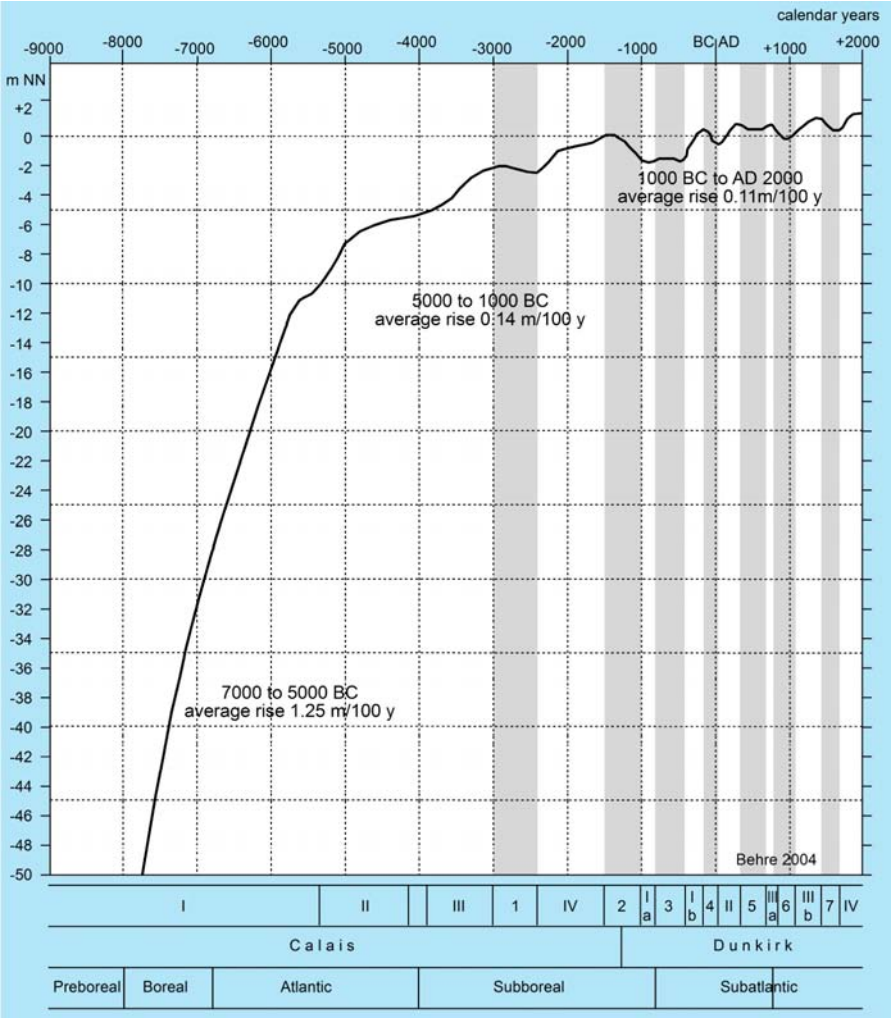


Figure 2.14: Transgression curve of the average tidal high water in the southern North Sea (source: K.-E. Behre, 2004).

were transhumant pastoralists who took their cattle to higher grounds during winter season. First salt marsh settlements were established on level terrain, but subsequently inhabitants began to raise their farmyards to keep them out of the water during storm tides. Collective raised mounds (*terpen, wierden, wurten* or *warften*) from sods and dung were built for safe housing in an otherwise amphibious marsh.

From the ninth to tenth century AD a great transformation of the coastal landscape set in. Swamps and bogs were systematically drained and converted into cultural land. Salt marshes came to be protected by earthen sea walls (dikes) repelling the floods and retaining fresh groundwater supplies. By the thirteenth century one to two meter high dikes surrounded most marshes. Valve sluices were used to discharge accumulating rainwater. The population increased and reached an unprecedented prosperity. Urban demands for cattle, cereals and dairy products boosted agriculture and commerce.

However, the dikes were feeble and major storm surges swept freely over their tops. The drainage of swamps and bogs had unforeseen repercussions, as it caused topsoil erosion and subsidence. Embanked marshes could no longer rise by regular deposition of fertile clay during inundations. In stagnant brackish waters mosquitoes multiplied. Malaria became endemic, leading to widespread health problems. Salt making was an important economy. To obtain salt, tidal peat banks were dug off, the peat dried and then burned. The salt was extracted from the ashes. This activity started in Roman times, and at the end of the Middle Ages most tidal bogs had disappeared. This reinforced erosion by an advancing sea. Apparently, human activities have contributed to the development of deep embayments such as Zuiderzee, Dollard and Jade Bay, and large parts of the Northfrisian area. Devastating floods caused the deaths of thousands of people and their livestock. Only part of the inundated land could be reclaimed in subsequent decades and centuries.

With the beginning of the Modern Age (1500 AD), dikes were reconstructed until they were strong enough to stand substantial storm surges. When the risk of flooding declined, a growing number of farmsteads were reallocated from knolls onto the flat ground. Extensive drainage guaranteed sufficient lowering of the water tables to intensify arable farming. Maritime trade also intensified, with islanders being particularly involved in shipping, trading and whaling.

From 1900 AD onwards, large-scale mechanisation of dike building, hydrological management, agriculture and fishing took place. The landscape was more and more redesigned to fulfil human needs. Many remaining bays were embanked, estuaries canalized and rivers dammed. On the islands, tourism developed into the major economic activity and entailed a sprawl of infrastructures. However, in the last third of the twentieth century a turning point was reached. The idea that a coastal landscape is something to be valued in itself has gained ground. Species and habitat protection and restoration efforts have been initiated on a large scale.

Breaking Waves (Photo: Klaas Kreuijer).

Winter in the Wadden Sea (Photo: Jan Huneman).

For centuries, the deep tidal inlets in the Wadden Sea area have formed the main shipping routes from the 'Zuiderzee' harbours to the open sea. Of these harbours, Amsterdam became the most important and developed into a central staple market within Europe. During the 16th century the focus of trade was directed toward the Baltic area, with the emphasis on grain trade. But from the 17th century onwards the trade with the East and West Indies in luxury commodities such as tea, coffee and tobacco rapidly gained importance. For this purpose, the Dutch East India Company (VOC) was founded in 1602. The large merchantmen used for the long distance trade were unable to pass the shallow waters of the 'Zuiderzee' to enter the Amsterdam harbour. Therefore, these ships were loaded and unloaded on the Texel roads in the western Wadden Sea. Protected from the northwestern winds by the Island of Texel, it was a relatively calm area. Relatively, because over the centuries thousands of these ships have been wrecked by storms. A notorious example is the Storm of Christmas Eve 1593, when more than 40 ships are said to have sunk in a single night. Until now, approximately 80 shipwrecks with archaeological significance have been located in this area.

The Wadden Sea is a high dynamic tidal area. Gullies cut deeply into the Pleistocene subsoil and are shifting constantly. Sediment is continuously eroded and redeposited. Ships that sank into such gullies deflected existing currents and, consequently, the course of these gullies. In a short period of time, these ships were covered and protected by a layer of sediment, which caused these wrecks and their (organic) content to stay extremely well preserved. This archaeological maritime heritage is of great importance on a national level. These shipwrecks reflect a period in the national history in which the Netherlands became an important maritime nation. But the significance of this heritage goes far beyond national meaning. The shipwrecks, which are of many different nationalities, form the physical testimony of the maritime exploration and trade of the 16th to 18th century that brought contact with distant parts of the world, sometimes for the first time. The number of wrecks and the extremely favourable preservation circumstances make the western Wadden Sea one of the richest archaeological resources of our common maritime heritage. That is why the western Wadden Sea is on the tentative list of the Netherlands as a cultural site (26/09/1995). However, the shipwrecks are not included in this nomination of the Wadden Sea. The reason for this is that at the moment, there is not a complete archaeological characterization of all the shipwrecks concerned. In addition, there is only little information on the number, the locations and the characterization of possible shipwrecks in the German part of the Wadden Sea. Therefore, much work still has to be done to establish a full inventory of the underwater cultural heritage of universal value for the Wadden Sea.

As the gullies keep shifting, the sedimentation-erosion process repeats itself. This situation can cause covered wrecks to be exposed again

Sunset in the Wadden Sea (Photo: Martin Stock).

or it may lead to the discovery of a new wreck and sometimes even several wrecks at the same time. Exposition from the protective sediment may be a threat to the long-term preservation of these shipwrecks by erosion, the woodboring shipworm (*Teredo navalis*) or by human activities such as looting. Therefore, the wrecksites and sedimentation-erosion patterns within the area are monitored on a regular basis. In the last two decades techniques also have been developed to physically protect these wrecks by covering them with nets with fine meshes that catch the sand, resulting in artificial mounds or reefs.

The shipwrecks and their environment are subject to protection under the Monuments and Archaeological Sites Act 1988, the Nature Conservation Act 1998 and the PKB. The Malta Convention was ratified by the Netherlands in 1998 and implemented in the Monuments and Archaeological Sites Act 1988. According to the PKB, monitoring of the shipwrecks as well as investigation and recovery of shipwrecks that are exposed from the protective sediment as a consequence of natural physical processes is allowed under certain conditions. These activities may not adversely effect the natural values and features. Human activities in the Wadden Sea may not damage the archaeological values present in the bottom of the Wadden Sea.

When flying over the Wadden Sea area of North Frisia at low tide, traces of earlier land cultivation, farming and settlements can be seen on the eroded banks of tidal gullies lining the mudflats or in areas where the mudflat substratum has been worn away by the flow of water. The remains of ditches used for drainage and soil improvement are the most common traces which appear. However, it is also possible to find the remains of roads and dikes, mound bases, wells and cisterns constructed from dried bricks of peat or clay, pits and stakes used for various purposes as well as areas used for the mining of peat for fuel and salt.

Walking out onto the mudflats, it is possible to date some of these structures, known locally as "Kulturspuren" (traces left by cultural development), with the help of archaeological evidence. In this way, it is possible to reconstruct the course of earlier land development and settlement and to outline the general contours of the development of land cultivation in space and time. Archaeological and geographical research has shed light on the complicated interplay between human manipulation of the environment, a rising sea level, and the increasing frequency and severity of tidal flooding. At the same time, interdisciplinary cooperation has shown that the morphological development of this coastal landscape cannot be fully understood without knowledge of the composition of the geological subsoil and, in particular, the consistency and strength of the Holocene sediments.

The present protection and management of the nominated property will ensure that such features are also protected as part of the nomination and remains an integrated part of the heritage. Small-scale traditional uses are small-scale activities, mainly carried out by local inhabitants, in ac-

cordance with regional customs and traditions. They are part of local heritage and give islanders a sense both of belonging and of freedom. These feelings are intense and, as such, they play an important part in shaping the islanders' identity. These uses enhance the involvement of local communities. These activities are only allowed if they do not cause significant damage to nature. The local authorities are responsible for supervising these uses. Examples are catching shrimp for own consumption (dragnet shrimp fishing), digging up lugworms and ragworms by hand, collecting shellfish by hand for own consumption, walking and strolling along the countryside.

Experiencing the scenic values

The complex and dynamic mosaic of the superlative natural phenomena formed by the geomorphological features and biologically rich and diverse habitats that constitute the Wadden Sea ecosystem forms one of the most dramatic and beautifully integrated landscapes and seascapes world wide. This can be experienced when walking on the "bottom of the sea" during low tide and crossing this vast expanse of interrelated land and seascape from the mainland to one of the many barrier islands. On the way one passes all the habitats characteristic of this system, including the salt marshes with their intricate gully systems and the mudflats near the coast, hard sandbanks and deep gullies where the water constantly moves in and out. Experiencing the marine environment on foot, where just a few hours before it was covered by some meters of water, surrounded by an endless sky where the sea meets the horizon deeply impresses most people visiting the Wadden Sea.

As far back as Antiquity, the vast area of the Wadden Sea and the dynamic transition between sea and land created a lasting impression on human observers. The earliest and most famous testimony is recorded in the 'Historia Naturalis' by Plinus Secundus (23–79 AD). Pliny's amazement was caused by the 'indistinctness' of the coastal formation, of which one could not tell, "whether this region was part of the mainland or part of the sea." It is not surprising therefore, that Pliny found the intimate link between the people in this region and this dynamic natural environment quite incomprehensible.

A fundamental re-interpretation of the visible world during the 17th - 18th centuries introduced the 'aesthetics of the sublime', which made it possible to ascribe a particular aesthetic quality to the elements of coastal landscapes. As a result, a new perception of 'pleasure' was derived from the stimulus to the human senses provided by the natural features of the Wadden Sea.

The completely open horizon with the apparently limitless sky above and the indistinct transition between the tidal flats and the sea creates an expansive experience and intense stimulation of the senses that cannot be equalled by any other comparable coastal formation. This creates a unique relationship between the high aesthetic qualities of the natural ensembles and of the extraordinary ecological features of the area. The extraordinary aesthetic importance of the Wad-

The wide horizon (Photo: Klaas Kreuijer).

den Sea Region is represented through a special kind of tension which can only be experienced with such intensity in this location: the tension between the 'overwhelming natural phenomenon' of a coastline that offers a particularly powerful experience of the sublime on the one hand, and the characteristic sharpening of the capacity for sensual experiences through what at first glance would seem to be unprepossessing natural phenomena on the other.

An inherent feature of the system is the continuous change of the flats, the deeps and the gullies from the largest to the smallest fraction. These morphological variations are in the aesthetic perception compounded by the infinite tidal rhythm. Nowhere else can the dynamic interplay between the sea and land be experienced on such a scale and richness in forms. Nowhere else is there such a variety of natural features in a coastal area: the hugeness of the area; barrier islands with large differences in land and seaside; tidal area with an enormous differentiation, uninterrupted over many hundreds of kilometres with a highly dynamic system of deeps and gullies constantly changing; estuaries and tributaries debouching into the area; and large areas of salt marsh area along the coast with islands and Halligen. These natural features dominate the land and seascape and are accentuated by humanity's constant struggle with the area for over a thousand years. It is this complexity of habitats and biotopes so intricately linked in an elaborate ecosystem that stimulates the observer with its superlative intricacy.

The serene beauty and peacefulness of the landscape and seascape are continually changing as a result of seasonal variations in climate and the rhythm of the tides. The onset of major winter storms can suddenly transform the placid waters into a wild and awesome setting of wild beauty that inspires great respect for the forces of nature. It is the intense tension between the human perception of the grandeur and beauty of the natural systems and their ability to instill awe that result in an exceptional attractiveness. The sheer scale and richness of the land and seascape in which anthropogenic features play an important role enhances the aesthetic value of the Wadden Sea. It has stimulated such famous novels as *The Dykemaster* by Theodor Storm and *The Riddle of the Sands* by Erskine Childers, as well as the world-known expressionist paintings by Emil Nolde. Childers and Nolde capture the very beauty of the "sands", the extended tidal flats and the silence and the awe under storm.

History of ecological changes

Large terrestrial mammals (e.g. aurochs, elk, bear) and birds (pelican, flamingo) were hunted during the earliest human occupation in the Wadden Sea and elsewhere in Europe and finally disappeared. During medieval and modern times, a gradual decline of waterbirds (e.g. herons, cranes, spoonbills, cormorants, ducks and geese) and marine mammals (e.g. grey seals, large whales) is assumed to have been caused by hunting. Large diadromous fish (e.g. sturgeon, salmon), groundfish (e.g. haddock, cod, rays) and oysters declined because of intensive fishing. This trend culminated in the nineteenth and twentieth centuries. The commercialization and intensification of exploitation inside and outside the Wadden Sea Area was a major driver for declines. This became obvious with the onset of protection programs for birds and seals in the twentieth century, which have resulted in a striking increase of populations.

For species depending on wetlands, river or estuarine habitats, habitat loss, destruction and degradation also played a significant role in declines. At the end of the twentieth century, 144 species (~20% of total macrobiota) were listed on the Trilateral Red List of threatened species for the Wadden Sea Area. Of these, 21 species were considered extinct in the twentieth century, while another four species had become extinct in earlier centuries. Habitat loss was considered to be the most important factor, particularly in extinctions of invertebrates and plants. Exploitation is assumed to be second in importance and has mostly affected vertebrates.

Dune areas on the barrier islands have been affected by stabilization for coastal defence purposes and by eutrophication. Some wet dune slacks became affected by groundwater extraction. More significant have been livestock grazing, pine plantations and the spread of introduced non-native species. Most notably are *Pinus* spp. and *Rosa rugosa* in grey and white dunes. The American cranberry *Oxycoccus macrocarpus* dominates in some dune slacks. In dry dunes with scarce vegetation a southern-hemisphere moss *Campylopus introflexus* is taking over. The cranberry and the moss seem to be competitively superior to native vegetation, while the Asian rose and various alien shrubs and trees took benefit from anthropogenic alterations in the dune environment. Also, the introduction of rabbits affected dune vegetation as has their recent population decline. Management attempts are underway to reverse some of these developments and to restore previous dynamics.

In the course of eutrophication, developments in phytoplankton, green macroalgae, and benthic macrofauna have been attributed to changes in nutrient and food supply to the coastal waters. A decline in intertidal seagrass beds may have been indirectly caused by reactive nitrogen enhancing epiphytic algae. In recent decades, riverine loads of nutrients have been declining but are still above pre-industrial levels. Respective changes have been observed in phytoplankton, but this may have been confounded by effects of climate change.

In the 1930s, seagrass became infected by an epidemic disease and the subtidal meadows never recovered. Up to now, 52 aquatic plants and invertebrates, brought from overseas with shipping and aquaculture, have become established in the Wadden Sea Area. This has not yet caused any extinctions of native species. However, most notably the cordgrass (*Spartina anglica),* which was planted into the Wadden Sea Area in the 1920s, and the Pacific oyster (*Crassostrea gigas),* introduced in the 1980s, do replace native species and have generated novel habitat structures in the Wadden Sea. Other exotic species also have become highly abundant, sometimes only intermittently and in other cases facilitated by climate change, i.e. warmer summers and milder winters since 1996. Apparently, each is filling an open opportunity which was available to their mode of life, e.g. the Japanese seaweed (*Sargassum muticum)*, a bristle worm (*Marenzelleria viridis)*, the American razor clam (*Ensis americanus)*, the American slipper limpet (*Crepidula fornicata)* and the Australasian barnacle (*Elminius modestus)* among others. In contrast to oceanic islands, isolated mountain tops and lakes, coastal environments along continental margins such as the Wadden Sea are inhabited by biota which have had a long history of contest with immigrants and thus are less likely to be strongly affected by introduced species.

The overall effect of ecological long-term change on ecosystem structure and functioning has led to a simplification and homogenization. Conservation efforts have reversed negative trends by enabling some birds and mammals to recover. Many salt marshes have been relieved of heavy livestock grazing, and drainage furrows are restricted to areas necessary for protection and against flooding and maintenance of dikes. This has significantly diversified the vegetation. Still, the present extent of salt marshes is only a shadow of its past. Also, many dunes and shorelines have been strongly modified, and the invasions of exotic species cannot be reversed.

Protecting and managing the ecosystem

Since the beginning of the last century, smaller nature reserves have been established in practically all parts of the Wadden Sea, primarily to protect breeding birds. Though the importance of the Wadden Sea for birds had been well known, it was only after the Second World War that scientists from the three Wadden Sea countries documented the significance of the Wadden Sea as one of the important ecosystems world-wide. In the 1960s-70s, major projects and developments such as large scale embankments, harbour and industrial developments as well substantial increases in tourism and pollution constituted significant impacts on the Wadden Sea ecosystem. Scientists and non-governmental organizations, such as the WWF, the German "Schutzstation Wattenmeer" and the Dutch Wadden Society, which had been established in 1965 in protest of a Dutch dam project, strongly advocated a comprehensive protection and conservation of the entire ecosystem which could effectively tackle the negative impacts both from inside and outside the Wadden Sea. The small scale nature reserves were too limited in their scope and inadequate instruments to protect an entire ecosystem, they contended.

The Wadden Sea environmental movement was the major force which resulted in the designation of comprehensive protection schemes by the responsible authorities in the countries and in the establishment of a trilateral Wadden Sea cooperation to protect the Wadden Sea as an ecological entity. It all started in the 1970s with designation of considerable parts of the Wadden Sea as nature reserves. Around 1980, major conservation schemes were introduced in all three countries, leading to a comprehensive protection of the Wadden Sea. The Dutch part was made subject to a planning decree in 1980, setting out the conservation objectives and regulating human activities. In 1985/86, the two German states Schleswig-Holstein and Niedersachsen declared their parts of the Wadden Sea national parks. The designations have since been amended and extended but the main traits of the conservation schemes introduced a generation ago have been maintained.

The Wadden Sea is further subject to a multitude of international designations. Most of the Wadden Sea Area has been designated Special Protection Areas under the Birds Directive and designated as habitat areas under the Habitats

Directive, which forms the Natura 2000 for the Wadden Sea. Further, most of the area has been designated as wetlands of international importance under the Ramsar Convention and Particularly Sensitive Sea Area by the International Maritime Organization.

In parallel, the three governments started a co-operation, with the aim of ensuring a coordinated protection of the Wadden Sea. The first trilateral Danish-German-Dutch Governmental Conference on the Protection of the Wadden Sea was held in 1978 in The Hague. The 10th Ministerial Conference was held on the Dutch island of Schiermonnikoog on 3 November 2005.

The formal basis of the Cooperation is the "Joint Declaration on the Protection of the Wadden Sea" signed at the Third Wadden Sea Conference in Copenhagen in 1982. The Joint Declaration is a declaration of intent of the three Wadden Sea countries to consult each other in order to coordinate their activities and measures to implement a number of legal instruments with regard to the comprehensive protection of the Wadden Sea region as a whole including its fauna and flora. In 1987, the Common Wadden Sea Secretariat was established to facilitate and support the Cooperation.

It is important to acknowledge that the trilateral cooperation is a political cooperation which aims at a coordinated implementation of relevant international legal instruments such as the European Union directives and strategies, the Ramsar Convention and the Convention on Migratory Species (Bonn Convention) in the field of nature and environmental protection for a comprehensive protection of the Wadden Sea. The ministerial conferences, which are held as a rule every 3-4 years, are the central decision making bodies for the cooperation.

Since 1997, the arrangements of the Wadden Sea Cooperation have been embedded in the framework of the Trilateral Wadden Sea Plan, which entails policies, measures, projects and actions agreed upon by the three countries. The Plan is a statement of how the three countries envisage the future coordination and integration of management of the Wadden Sea Area and of the projects and actions that must be carried out to achieve the commonly agreed Targets.

Perspectives

The economy of the Wadden Sea Area is likely to shift further from agriculture and fisheries towards tourism and, perhaps, to alternative energy in the form of wind, water and photovoltaic power, as well as biomass. Pollution and eutrophication is expected to decrease strongly as a consequence of European policy. Stemming the tide of unintentionally introduced species in the wake of globalization will be difficult.

Like all other coastal wetlands in the world, the Wadden Sea will be increasingly affected by global warming with a slow but inevitable rise in sea level. New species from southern regions will immigrate, some resident species will retreat towards northern regions, and introduced species adapted to warmer conditions will proliferate. Nevertheless, the Wadden Sea ecosystem may be expected to retain most of its unique composition and functioning, because coastal species are adapted to a wide range of temperature variation. A more serious threat is the long-term prospect of a rise in sea level on the order of one to two meters.

Sediment ripples on the Wadden Sea mudflats (Photo: Jan van de Kam).

3. JUSTIFICATION FOR INSCRIPTION

The Wadden Sea forms an interface between a continental riverine catchment area of about 400,000 km² on the landward side, and the North Sea and an Atlantic shelf to the west. The Wadden Sea contains a complex mosaic of sand and mudflats, tidal channels, salt marshes, seagrass meadows, mussel banks, sandbars and barrier islands extending over an area of some 14,000 km² where natural processes proceed in a relatively undisturbed manner.

The complex and dynamic mosaic of the natural phenomena formed by the geomorphological features and biologically rich and diverse habitats that constitute the Wadden Sea ecosystem forms one of the most dramatic and beautifully integrated landscapes and seascapes world wide.

3.a Criteria under which inscription is proposed

The Wadden Sea represents a natural system of outstanding universal value based on the following inscription criteria:

Criterion viii: *"be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features"*

The Wadden Sea has evolved over the last 8,000 years being a very young ecosystem in geomorphological and evolutionary terms. It represents an outstanding example of the Holocene development of a temperate-climate sandy barrier coast under conditions of rising sea level. The Wadden Sea is unique in that it consists entirely of a sandy-muddy tidal system with only minor river influences on morphodynamics. The Wadden Sea ecosystem is characterised as tidal flats and barrier island system with extensive salt marshes. The Wadden Sea differs from other systems of this type in that it is the only tidal flat and barrier island depositional system of this scale and diversity in the World. There are no systems in the world that compare to the Wadden Sea.

An inherent feature of the system is the continuous change of the flats, the deeps and the gullies from the largest to the smallest fraction. The tidal-channel systems can be regarded as 'statistical self-similar fractal', i.e. the whole has the same shape as one or more of the parts networks and the similarity of the channel systems points to a self-organising nature. On smaller scales, fractal patterns are also found in the muddy deposits. These morphological variations are in the aesthetic perception compounded by the infinite tidal rhythm. Nowhere else can the dynamic interplay between the sea and land

be experienced on such a scale and richness in forms. Nowhere else is there such a variety of natural features in a coastal area: the hugeness of the area; barrier islands with large differences in land and seaside; tidal area with an enormous differentiation, uninterrupted over many hundreds of kilometres with a highly dynamic system of deeps and gullies constantly changing; estuaries and tributaries debouching into the area; and large areas of salt marsh area along the coast with islands and Halligen. These natural features dominate the land and seascape and are accentuated by humanity's constant struggle with the area for over a thousand year. It is this complexity of habitats and biotopes so intricately linked in an elaborate ecosystem that stimulates the observer with its superlative intricacy.

The Wadden Sea contains very fine examples of post-glacial coastal geomorphology and the dynamic interaction of physical and biological processes on a scale that is not found within one unified system anywhere else in the world. Despite man-made interventions the continuing presence of these dynamic natural processes ensures the development and rejuvenation of landforms including the whole range of habitats, and secures the maintenance of ecosystem functions. The Wadden Sea ecosystem will thus continue to serve as an important bio-physical reference for the study of the effect of sea level rise and it will be important to consider this function as a legitimate part of the World Heritage concept.

Although tides with lower mesotidal to macrotidal amplitudes dominate the morphological evolution of the Wadden Sea ecosystem, wind stresses and waves also play a major role in the morphology of the Wadden Sea ecosystem. The morphological succession of the wetland system commences with sand flats in the seaward sections, followed by mixed flats and finally mud flats along the mainland shore and in embayments. In contrast to other parts of the world, the tidal flats of similar systems are merely occupied by eelgrass meadows or *Spartina* here and there. The mobility of sediments has prevented basin-wide encroachments by upright growing vegetation in the case of the Wadden Sea. This has created the unique character of its seascape of mainly unvegetated shoals divided by an intricate fractal-channel pattern. This unique feature of the Wadden Sea is mentioned in many international textbooks as the example, par excellence, of extensive post-glacial meso to macro-tidal flat development.

There are also sedimentary features, such as naturally open barrier coasts consisting of dunes intersected by small overwash areas that are unique to NW-Europe. Another example is the unique sawtooth-shaped and swale topography along the barrier island coastline that is thought to be the result of near-shore wave/current generated resonance phenomena that form incised rip-current channels.

Excellent and broad scale examples of bio-geomorphological processes can be found in the coastal dunes, the channels, the tidal flats and the salt marshes. Because the Wadden Sea contains many different types of islands, sheltered and exposed dunes and subsequent sheltered and exposed types of salt marsh and green beaches there also is a great variety in vegetation types and communities.

The significant ongoing geological and geomorphological processes driving the development of landforms are continuously renewing the geomorphic features of the landscape and seascape within the lifespan of man. The Wadden Sea's outstanding universal value is maintained through the strong hydraulic and aeolian dynamics that form the prominent morphological changes on a variety of spatial and temporal scales, from whole groups of inlet systems that influence each other over many centuries, down to the shifting of a sand ripple in the order of minutes. These morphodynamic adjustments are possible due to the fact that the Wadden Sea system can still react in a natural way to human influences, allowing it to evolve freely to a large degree.

The Wadden Sea attracted the interest of scientists from an early stage of scientific endeavour and is one of the earliest and best-studied depositional systems. As such it is an important international reference area for tidal flat system studies. Long-term depositional processes have led to the formation of a series of Holocene sedimentary deposits, which provide details of the development of the Wadden Sea and the regional climate in great detail. This has allowed geoscientists to establish comprehensive archives of documentary evidence of tidal processes, stratigraphy, sedimentary structures and sediment distribution patterns.

The biological systems and their interactions with geological and geomorphological processes in the Wadden Sea have also been studied in great detail over a similar long time. The comprehensive archives of bio-geophysical data form an historical record of the response of the Wadden system to sea level rise. These archives illustrate the ongoing processes and have formed the basis for numerous publications, maps, drawings, and other materials of immense value to the natural sciences and the

Glasswort, typical at the edge of the salt marshes (Photo: Klaas Kreuijer).

sustainable use of the Wadden Sea ecosystem, and form an international reference for comparative studies with other tidal wetland ecosystems and their response to global change.

The unique geomorphological character of the Wadden Sea also has direct links to other World Heritage themes such as "stratigraphic sites". The Holocene stratigraphic records of the Wadden Sea form part of the overall geological inventory accumulated in the archives of numerous coastal research institutions. These invaluable and unique materials documenting the genesis of the Wadden Sea are unparalleled and form a universally important archive of the Holocene history of sea-level rise, climate, and depositional response.

The Wadden Sea is subject to sea level rise as a result of climate change and tilting of the earth's surface. It has always been able to react in a natural way to relative rise of the sea level. Scientific opinion is that it will be able to respond to increased sea levels in the foreseeable future because the morphodynamic and biological processes that maintain the health and productivity of the ecosystem have the freedom to adapt. There are only very few areas worldwide where it is possible to experience the dynamic adaptation of bio-geomorphological processes within a generation.

An expert statement "The Outstanding Universal Value of the „Wadden Sea": A Geological Perspective", which in further detail substance the inscription under this criterion, is in **Annex 01**.

Criterion ix: *"be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals"*

The Wadden Sea is a unique coastal ecosystem with enormously productive marine biota and with linkages far beyond its narrow geographical boundaries. It is one of the last remaining natural large-scale inter-tidal ecosystems in Europe where natural processes continue to function in an undisturbed manner. Excellent and broad scale examples of biogeomorphological processes can be found in the coastal dunes, the salt marshes, and on the tidal flats on mussel beds and sea grass meadows. This transitional environment between land and sea is characterized by the constant change of flood and ebb tides, great fluctuations in salinity, high temperatures during summer and occasional ice cover in winter. These circumstances have created numerous ecological niches, colonized by species that are adapted to the extreme environmental conditions.

The Wadden Sea is an ecological transition zone between land and ocean. With its estuaries, marshes and particularly its wide intertidal zone intersected by deep gullies, the Wadden Sea functions as a gigantic coastal filter system. Freshwater and marine waters are mixed and flushed to and fro with the tides, transporting huge amounts of

Swimming bog at Sehestedt, Jade Bay (Photo: Martin Stock).

sediments, organic matter and nutrients. These riverine and marine imports of materials form the basis of the trophic system. Imported organic material is mineralized in the marshes, tidal flats sediment and shallow waters. The release of nutrients from this spacious purification plant, together with those nutrients supplied from the catchment area and the Atlantic waters, fuels outstanding primary production. Due to the active biota, this filter never clogs but is continuously renewed.

Natural processes such as tides, wind, currents, waves and a series of biological processes occurring in a large area have resulted in the richness of geomorphological and biogenic structures. Due to the undisturbed presence of these processes, structures are not only conserved, but there are also rejuvenation cycles, creating new structures and breaking down old structures representing all stages of succession. Examples are the dunes and salt marshes that can be found in various stages of succession, and structured mussel banks, which are formed by a combination of growth and food depletion from the overlying water.

From a physical point of view, the Wadden Sea combines two extremes. The stability and rather dampened fluctuations in the physical properties of oceanic waters with their high heat capacity meets in the Wadden Sea the strong and rapid physical fluctuations of the terrestrial environment. The mix of these two regimes gives rise to the unique ecological character of the Wadden Sea when projected on the large expanses of the shallows and the flat land.

Due to the shallowness of the area and the transitional boundaries between land and sea, there is a strong interaction between biota and geomorphological processes, i.e. bio-geomorphology. The Wadden Sea morphology and geomorphological processes contain gradients between high and low, wet and dry, and sedimentation and erosion. These gradients and the processes that cause them, have a direct influence on gradients in grain size of the sediment, nutrient levels, organic matter levels and moisture. Plants and animals are tuned to specific conditions and will therefore be abundant in specific locations. The geomorphological influence on biota is most direct in respect to inter-tidal habitats and their flora and fauna. Conversely, the biological influence of biota on geomorphological processes creates, maintains, or transforms their own geomorphological surroundings. This is demonstrated by the influence of vegetation on the hydraulic resistance, erodibility and sedimentation, or by the influence of fauna on sediment characteristics through bioturbation and bio-stabilization.

The Wadden Sea forms an outstanding example in which biogeomorphological interactions are clearly demonstrated in the shallow, productive waters and various sedimentary environments. Important in this respect is that the Wadden Sea has many examples in which the timescale for geomorphological changes coincides with the timescale for biological changes. This results in mutually interacting processes. Unlike other areas in the world, landscape processes are not domi-

nated by geological timescales nor do biological processes dominate landscape features. This means that the constantly changing landscape requires adaptation of organisms and at the same time that organisms affect their environment as 'ecosystem engineers'. Excellent and broad scale examples of these biogeomorphological processes interactions can be found in the coastal dunes, the tidal flats and the saltmarshes. Of particular interest are for example the intertidal mussel beds. These form a biogenic structure that has considerable influence on the morphology of the tidal flats; they stabilize the sediment, preventing it from erosion and actively accrete silt. The numerous macrobenthic species can have an opposite effect. Their constant reworking of the sediment (bioturbation) makes the seabed more susceptible to erosion. Saltmarshes form another example in which the capturing of sediment increases the bed level, which leads to changes in vegetation composition and subsequent changes in sedimentation rates.

The Wadden Sea provides a multitude of transitional zones between land, the sea and freshwater environment, which is the basis for species richness. Among these organisms, there is a high degree of ecological specialization. On the tidal flats, the microbiota is highly diverse too, while only a few species of macroflora and macrofauna are adapted to the extreme environment. Of these, however, exceptionally high numbers and biomass can be found. The high productivity is most significantly demonstrated with respect to fish, shellfish, and birds.

The productivity of the Wadden Sea in terms of biomass is one of the highest in the world. A special feature of the Wadden Sea is that primary production is dominated by microscopic algae that cover the sediment surface of the tidal flats as microphytobenthos and drift in the shallow coastal waters as microphytoplankton. In spite of turbid waters, the periodic tidal exposure and shallowness guarantees sufficient light for photosynthesis. The gross primary production by microphytobenthos is the highest in the world for locations north of 42° latitude. The contribution of microphytobenthos to the primary production is about as high as the local primary production by planktonic algae.

The very fact that most photosynthetic production is generated in the form of unicellular algae allows for highly effective consumption. These miniature plants are more readily consumed by invertebrate herbivores than larger plants. As a result of this high production of easily consumable benthic and planktonic food, the biomass of marine invertebrates on the tidal flats is on average 20 times higher than offshore benthic systems in the North Sea. This is what makes the Wadden Sea tidal zone so attractive to secondary consumers from outside, and explains the dense swarms of shrimp and small fish and the spectacular flocks of birds that congregate there.

The Wadden Sea is an integral part of the North Sea, one of the few shallow and relatively sheltered seas in the Northern Hemisphere and one of the most highly productive fish grounds world-wide. The Wadden Sea plays an important role in this high productivity. As a shallow sea, the benthic-pelagic coupling is notably strong, and the primary production and secondary production are high. This production forms a foundation to the intricate food web that ultimately results in an important nursery area for fish, a foraging and resting habitat for seals, and a foraging habitat for waders and other waterfowl, which are of international importance. For aquatic consumers, the shallow waters of the Wadden Sea serve as a vast nursery. Plenty of food, benign higher temperatures in the shallows than further offshore in spring, and the absence of large predaceous fish where the water level fluctuates with the tides, all of these contribute to a high turnover of nurslings. The Wadden Sea is an important nursery area for sole (*Solea solea*), plaice (*Pleuronectes platessa*) and dab (*Limanda limanda*). They grow up rapidly in spring and summer, and leave the Wadden Sea towards offshore waters when the cold seasons commence. For some fish that commute between inland waters and the open sea in the course of their life cycle, the rich food sources of the Wadden Sea constitute an important intermediate staging area. Good examples of diadromous fish species are flounder (*Platichthys flesus*), smelt (*Osmerus eperlanus*) and eel (*Anguilla anguilla*). Marine organisms manage to dominate the entire tidal zone. The plentiful supply of materials from land and ocean allows the marine food web to provide ample food for the waders, gulls and ducks. Migrants support or exploit distant ecosystems along the East-Atlantic flyway. In addition, there are birds that exploit the Wadden Sea in winter. Similar long-distance links apply to fish and some crustaceans.

The birds feed primarily on the extensive sediment flats during low tide exposure. Some species also exploit the marshes and others dive in the gullies for food. Although the availability of the food is crucial, it is more than just high benthic biomass that supports the enormous number of

birds. Food availability may be highly variable at a particular site, depending on weather, disturbances and competitors, however the vast size of the continuous tidal area secures sufficient alternatives if one site fails. Another important factor that is sustaining the large populations of birds are abundant nearby resting and moulting areas, usually on sand bars and islets remote from any human disturbance. This aspect is also of primary importance for the seals, using the Wadden Sea as a nursery and resting area.

The present form of the Wadden Sea is mainly the result of natural forces. There may be other coastal areas with similar ecosystem functions, but none comes close to the Wadden in terms of such a large and coherent area of inter-tidal habitats of such high diversity.

An expert statement "The Outstanding Universal Value of the „Wadden Sea": An Ecological Perspective", which in further detail substance the inscription under this criterion, is in **Annex 02.**

Criterion x: *"contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation"*

The tidal flats in the Wadden Sea form the largest unbroken stretch of sand and mudflats worldwide, accounting for 60% of all tidal areas in Europe and North Africa. As such it is 'the only one of its kind' and many textbooks refer to the Wadden Sea when describing inter-tidal habitats and the rich and diverse flora and fauna they sustain. The tidal flats and the salt marshes form the largest coherent habitat of this type in Europe and constitute an essential element of the Wadden Sea ecosystem.

Marram grass on Norderney (Photo: Norbert Hecker).

The Wadden ecosystem represents one of the internationally most important wetlands. It is internationally recognised as a biologically highly productive ecosystem of great natural, scientific, economic and social importance.

The Wadden Sea is extremely rich in environmental gradients and transitional zones, yielding many different (micro) habitats that form the basis for ecological specialization under extreme conditions. The salt marshes host about 2,300 species of flora and fauna. The marine and brackish areas support a further 2,700 species. In total it is estimated that the Wadden Sea Area provides habitats for up to 10,000 species of unicellular organisms, plants, fungi and animals.

The large size of the Wadden Sea allows the diverse species to survive by spreading over several habitats, or by adopting a series of niches over the course of time. This constantly opens up territory for use by other individuals or species, and accounts for a high capacity to accommodate migratory species.

The marine deposits remain permanently flooded (subtidal) or are either periodically (intertidal) or episodically (supratidal) flooded by marine and brackish waters or in some cases even freshwater. Terrestrial soils range from very wet to extremely dry in the coastal dunes. High temperatures during summer and occasional ice cover in winter, and above all powerful storms with heavy rainfalls create these highly variable ecological niches for life. Under such circumstances, most species have adopted an extreme versatility. Others have evolved a high degree of specialization to survive the extreme environmental conditions. A high degree of endemism is not a characteristic of coastal wetlands. They are all relatively young and are interconnected by the flow of water which prevents the genetic isolation of populations. The outstanding feature of the Wadden Sea is the complex mixture of species from a wide array of regions and habitats as well as a mixture of residents, migrants and casual visitors, as well as high abundance of individuals instead of high biodiversity at least in the tidal flats.

The rich and diverse habitats are of outstanding international importance for birds as staging,

Bar-tailed godwit (Photo: Jan van de Kam).

moulting and wintering areas. According to the 1% criterion of the Ramsar-Convention, which is an internationally recognized measure to identify wetlands of international importance, the Wadden Sea is of outstanding international importance as a staging, moulting and wintering area for at least 52 populations of 41 migratory waterbird species that use the East Atlantic flyway and originate from breeding populations as far away as northern Siberia or Northeast Canada. Numbers of 44 populations of 34 species are so high, that the Wadden Sea is indispensable and often main stepping stone during migration, or as their primary wintering or moulting habitat. Therefore the Wadden Sea is essential for the existence of these bird species. A severe deterioration of the Wadden Sea implies a biodiversity loss on a worldwide scale.

Adding up the numbers, results in a maximum of some 6.1 million birds present at the same time in the Wadden Sea. Each year on average 10 to 12 million birds migrate back and forth between their breeding grounds in Siberia, Scandinavia, Greenland and Northeast Canada and their wintering grounds in Europe, Africa and even further South. Most species reach highest numbers during autumn migration; numbers of waders are almost as high during spring, whereas ducks and geese over-winter in high numbers; only gulls reach considerable numbers in summer. Almost the entire population of the dark-bellied brent goose (*Branta b. bernicla*) and the entire West-European population of dunlin (*Calidris alpina*) use the Wadden Sea during several periods of the annual cycle. Without the Wadden Sea their populations would suffer heavily. Additional seven species are present with more than 50% and further 14 species with more than 10% of their flyway population. Wadden Sea areas including the coastal zone of the adjacent North Sea are used by high numbers of moulting Shelduck (*Tadorna tadorna*) and moulting and wintering eider (*Somateria mollissima*).

Although bird migration is a global natural phenomenon that cannot be associated to a single site, the Wadden Sea is a vital and irreplaceable stepping stone that is considered a critically important 'mega-site' for bird migration. It is not just one of several stopover sites on the East-Atlantic flyway, but it is *the* essential stopover.

The millions of migratory birds, which pass through the area in spring and autumn and in huge flocks convey a scenic depth to the area which can be seen nowhere else on this scale, enhance the exceptional beauty and perceptive value of the area. This reinforces the unique relationship between the high aesthetic qualities of the land and seascapes and the extraordinary ecological features of the area.

The Wadden Sea is an important reproduction area for more than 30 species of breeding birds. For 5 species, at least 25% of northwestern European populations breed in the Wadden Sea. The ecological support for resident and migratory birds is of outstanding universal scientific value because the study of migration can only be executed on this large scale in the Wadden Sea.

The Wadden Sea may be considered of lesser importance as a permanent home for rare or endangered species. However, when the large population and variety of different mammals, birds, fish, crustaceans, molluscs and other animals as well as plants that are sustained by the Wadden Sea's ecosystems are considered, the Wadden Sea plays a very important role as a habitat of great international significance.

The Wadden Sea also constitutes a refuge in the life cycle for those species that have lost their inland habitats e.g. northern lapwing, redshank and black-headed gull. Without the Wadden Sea, several European bird populations would be endangered or even lost. The Wadden Sea is also an essential staging area for fish migrating between rivers for spawning and the oceans for feeding or vice versa. These fish could not complete their life cycles without the nutritious habitats of the shallow Wadden Sea. This also applies to many fish and invertebrates that rely on the tidal zone as a nursery and spend their adult life further offshore.

A unique feature of the Wadden Sea harbour seals is that they rely on the Wadden Sea tidal sandflats for resting and whelping. Their resting habitat disappears during high tide and, therefore, their behaviour is completely adapted to these conditions. The Wadden Sea sustains approximately 20% of the world-population of harbour seals (some 15,000 individuals in 2006) that belong to a sub-species (*Phoca vitulina vitulina*), which is found mainly in UK, Icelandic, Norwegian and Wadden Sea waters. In recent years, grey seals started to re-establish themselves in the Wadden Sea, first a haul/out rookery off the German Island of Amrum, followed later by a few rookeries in the western part of the Dutch Wadden Sea. The most important calving and nursing site for the harbour porpoise (*Phocoena phocoena*) population of the central North Sea is off the coast of the Wadden islands Sylt and Amrum.

Overall, after centuries of extensive exploitation in the Wadden Sea, protection measures have triggered a striking comeback in many of the resident bird species and also of seals, which have shown a very good recovery within the last three decades, and also after the two virus epizootics in 1988 and 2002. Hunting of seals was stopped in the seventies and essential habitats are kept free from human disturbance.

The expert statement in **Annex 02** also in further detail substances this criterion.

3.b Proposed statement of outstanding universal value

The Wadden Sea forms the largest unbroken system of tidal sand and mud flats worldwide with natural dynamic processes proceeding in a widely unimpaired natural state. It is one of a kind on earth. The Wadden Sea ecosystem represents one of the most important international wetland habitats that provide the basis for exceptional high biological production, species diversity and a high degree of ecological specialization and potential for adaptation.

It is an outstanding example of the ongoing Holocene development of a sandy coast under conditions of rising sea level and is unique in that it is the largest extensive tidal flat and barrier island depositional system in the World. Its geological and geomorphological features are closely entwined with biophysical processes and provide an invaluable record of the ongoing dynamic adaptation of coastal environments to global change. The biogeomorphological interactions are notably strong and unique at all scales.

The high primary and secondary production in the Wadden Sea sustains species of birds, fish and crustaceans and seals well beyond its borders. The rich and diverse habitats are of outstanding international importance as an essential habitat for migratory water birds using the East Atlantic Flyway and other migration routes between South Africa, Northeast Canada, and northern Siberia. It is one of the few shallow seas in the Northern Hemisphere with a high production of fish and serves as an essential spawning, feeding and nursery area for species migrating between freshwater and saltwater.

The mosaic of natural phenomena including the complex geomorphological features and biologically diverse and rich habitats, the unparalleled vastness and expanse in terms of the spatial dimension and the millions of migratory birds passing through in spring and autumn combine to form an exceptional and beautiful land and seascape.

The nominated property encompasses all the biophysical and ecosystem processes that characterise a natural and sustainable Wadden Sea. The standards of protection, management (including coastal protection measures) and monitoring ensure that the natural Wadden ecosystem, with all its component parts, will continue to evolve naturally and to sustain human uses. Man's use of the natural resources in a sustainable way including small-scale traditional uses is a key to help guarantee its integrity for generations to come.

Hallig Süderoog
(Photo: Martin Stock).

3.c Comparative analysis (including state of conservation of similar properties)

As outlined in the previous chapters, the Wadden Sea is an extensive coastal tidal and mud flat system. The Wadden Sea mudflats are characterised by their location in tidal inlets of barrier islands. They contain a sequence of large and small ebb and flood gullies and their energy gradients follow from the morphology. The Wadden Sea is a mesotidal barrier island system that only has minor river influences fringing the flat and low-lying coastal plain. In accordance with the Operational Guidelines a comprehensive comparative analysis has been made of similar properties which is in **Annex 03**.

By comparing the Wadden Sea with the currently 31 listed World Heritage sites with significant marine components and the 24 World Heritage coastal island sites with no (or insignificant) marine areas it becomes apparent that there is only one listed property which the Wadden Sea compares with, and that is the Banc d'Arguin in Mauritania.

44 non-listed sites have been selected for the comparative analysis of a list of 350 intertidal mudflats world-wide. These 44 non-listed sites are mudflats larger than 300 km^2. An overview of these sites, their size, coordinates and types is in Table 1 of the comparative analysis in **Annex 03**.

As outlined above the Wadden Sea is a mesotidal barrier island system that only has minor river influences fringing the flat and low-lying coastal plain. Most of the mudflat systems in the world are connected to estuaries and bays. Some are connected with barrier islands that are closely related to rivers and their deltas, such as the Mississippi delta. Only 5% of these deltaic barrier islands are found in North America and Europe, due to differing sea level rise history. A further criterion, therefore, is the presence of barrier islands that do not have a river delta origin. Of all mudflat sites larger than 300 km^2 this results in one comparable area: The Georgia Bight.

The primary features of the two comparable properties, Banc d'Arguin and the Georgia Bight according to the criteria under which the Wadden Sea is nominated, are listed in Table 3.1. It should be acknowledged that the criteria and the associated features are to be considered integral features of the whole range of geomorphological and biophysical processes and interactions.

The Banc d'Arguin is a relic of former river deltas, which once flowed from the central Saharan basin to the Atlantic (indeed the Banc d'Arguin has been called "a warm Wadden Sea"). Bird numbers recorded at the Banc d'Arguin easily reach the millions. Both are large tidal areas and extraordinary productive ecosystems supporting a rich fish fauna with varied populations of piscivorous breeding birds. They both support huge populations of migratory waterfowl on the East Atlantic Flyway, thus being strongly linked to each

Table 3.1: Features of the Wadden Sea, Banc d'Arguin and Georgia Bight according to the criteria viii, ix and x.

Features	Criteria	Wadden Sea	Banc d'Arguin	Georgia Bight
Designation WH		**To be nominated**	**1989 under criteria ix and x**	**-**
Country		**Germany / Netherlands**	**Mauritania**	**USA**
Climate zone		Temperate	Continental, arid subtropics, dry	Temperate
Description setting		Mixed energy to tide dominated mesotidal barrier coast (not deltaic)	Back barrier islands and open mud flats, relic of former deltas	Mixed energy to tide dominated mesotidal barrier coast (not deltaic)
Total area		10,000 km²	12,000 km² (50% marine)	8,000 km²
Mudflat area		4,500 km²	630 km²	300 km²
Tidal differences / range	viii	1.5 – 3.5 m	2.1 m	0.8 – 2.5 m
Mean wave height/ range		1.0 – 2.0 m	1.4 m	0.6 – 1.0 m
Contiguous character		Large and contiguous area of intertidal habitats	Contiguous between Cap Timiris and Pointe Minou, isolated section at Cap Blanc	Not a contiguous intertidal system
Major estuaries		5 estuaries	0 estuaries	13 estuaries
Productivity	ix	Primary production (gC/m²/y): phytoplankton 100-200; microphytes 150; seagrass 500; macrophytes 500-1,000	Primary production (gC/m²/d): phytoplankton 2.1-8.9	Primary production (gC/m²/y): phytoplankton 200-400; microphytes 60; seagrass 150-700; macrophytes 800-2,000
Habitats, biotopes	ix / x	Complex mosaic of bare intertidal flats fringed by saltmarshes, tidal channels, seagrass meadows, mussel beds	Sand dunes, coastal swamps, small islands, intertidal areas with 80% seagrass cover	Tidal channels with narrow band of bare intertidal flat. Intertidal almost completely covered by *Spartina* and *Juncus* saltmarshes
Salt marshes		310 km²	591 km²	4,237 km²
Mangroves km²		None	31 km² mangrove *Avicennia africana*	Some mangrove *Avicennia germinans*
Migrating birds	x	6.1 million present at the same time; on average 10 to 12 million each year; East Atlantic Flyway	2.1 million overwintering birds (106 species); East Atlantic Flyway	Important stop-over for millions of migrating birds; West Atlantic Flyway
State of conservation		Subject to a comprehensive international, trans-boundary and national protection and management system, RAMSAR site, PSSA by IMO, MAB by UNESCO, EU Natura 2000, EU WFD, contracting party of African-Eurasian Waterbird Agreement (AEWA)	RAMSAR site, National Park, has Fondation Internationale du Banc d'Arguin (FIBA) as management authority, not contracting party of AEWA	Not contiguously protected. Two Western Hemisphere Shorebird Reserves, Carolinian-South Atlantic MAB, no RAMSAR sites, no PSSA.

Brackish marsh in the Weser estuary (Photo: Imke Zwoch).

other and constituting the key feeding and resting areas on this flyway.

There are also significant differences. The marine area included in the property is only half of the listed property (6,000 km²) and only a very small part of that area - about 10% (630 km²) - is intertidal area. The Banc d'Arguin does not have barrier islands. Furthermore, the area is located in another climatic zone, the tropics, making it very different from the Wadden Sea in terms of the governing processes.

The Georgia Bight (also named South Atlantic Bight) extends for a distance of 1,200 km between Cape Hatteras in North Carolina to Cape Canaveral in Florida. Both, the German Bight as well as the Georgia Bight are mesotidal barrier coasts that fall within the mixed energy / tide-dominated classification and both have a coastal development affected by Holocene sea level rise.

The major difference between the Georgia Bight system and the Wadden Sea is that the Wadden Sea has open intertidal flats fringed by salt marshes, whereas the tidal basins along the Georgia Bight comprise tidal channels, narrow intertidal flats fringing the channels, and huge expanses of *Spartina* marsh which occupy what would otherwise have been open intertidal flats. The reason why *Spartina* has managed to encroach upon the former tidal flats is the large supply of mud (grain sizes <0.063 mm) to the coast by the local rivers. As a consequence, vertical accretion along the fringes of the marsh was so rapid that *Spartina* was able to occupy almost the entire intertidal area. The Georgia Bight tidal system thus looks very different from the Wadden Sea and also differs substantially in its ecology.

In conclusion, the Wadden Sea is to be regarded as of outstanding universal value compared to similar areas world-wide.

Parts of the Wadden Sea have been managed for hundreds of years to control flooding and to reclaim areas in particular to form agricultural lands. Despite some reduction in the areal extent of the ecosystem, these management interventions have maintained its natural dynamic processes and ecological functions. Over the past twenty years there have been enhanced efforts to protect and manage the Wadden Sea ecosystem in a sustainable way. There now exists a system of complementary national and international protection and management schemes that have produced remarkable results. The adverse impacts of pollution and input of nutrients to the area have been substantially reduced. The Wadden Sea in spite of its location on the rim of one of the most developed parts of Europe has maintained all the features that belong to a natural and sustainable ecosystem of outstanding international value.

In comparison to the other two areas, the Wadden Sea stands out as a remarkably well-conserved ecosystem. Comparing the Wadden Sea with the Great Barrier Reef in Australia is by no means fanciful in this respect. Both areas are incomparable to other systems and subject to a comprehensive protection scheme and ecosystem management.

3.d Integrity

The nominated property comprises all the habitat types, including all features and processes that belong to a natural and dynamic Wadden Sea. The offshore area encompasses the barrier islands and constitutes a coherent geomorphological system that is linked to the inter-tidal processes and systems. It includes the tidal inlets between the islands with their highly dynamic sediment transport and constantly migrating sandbars. The area is important for young fish and foraging and moulting ducks, for seals and harbour porpoises. The islands and salt marshes form a unique habitat for vegetation, especially adapted invertebrates and breeding bird species. The tidal area of the Wadden Sea system encompasses the tidal flats and the subtidal area and is characterized by an ever-changing pattern of gullies and flats.

The property includes all areas that are essential for maintaining the whole range of geomorphological processes that ultimately determine the biophysical, ecological and biological processes that are essential for the long-term conservation of the ecosystem and the biodiversity of the property. The Wadden Sea property is the singular most important coastal tidal area worldwide. Its importance is signified by its central role for migratory birds on the East Atlantic Flyway. Notwithstanding the human induced impacts on and modification of the property within in particular the last two generations, the Wadden Sea ecosystem contains all the elements that distinguishes it as a complete ecosystem in which the physical, ecological and biological processes continue to proceed to a wide extent in an undisturbed way. These same processes have created the beauty of the property, which is so highly regarded throughout the region.

The tidal flats are inhabited by a very rich and productive flora and invertebrate fauna associated with mussel beds and sea grass. The salt marshes form the upper part of the intertidal zone and are home to high concentrations of plant and invertebrate species of which many are endemic. The salt marshes also form important resting, breeding and feeding grounds for many bird species. The estuaries are characterized by high variability and are dynamic. They form an essential transition zone between the freshwater, brackish and the tidal area, and therefore form an important habitat for specialized species. They have been included in the property to only a limited extent since they are gateways to the harbours in the Wadden Sea region and in many cases represent a highly modified habitat type.

The nominated property has sufficient size to contain a functional coherence. Morphodynamic processes can take place without restrictions. Biological processes, which depend on and affect geomorphology can be found on many spatial and temporal scales, from seasonal microphytobenthos mats gluing the sediment together to salt marshes raising the sediment level and growing with sea level rise. Because of the size, the length and the different conservation regimes most of the natural biotopes of the barrier island salt marsh and tidal flat system still exist. Especially the mutual dependency of biotopes and habitats and completeness of the entire system can be found in the Wadden Sea. The quality of the area for migrating birds also is partly the result of its large size, which makes it easier to retreat to other parts of the area when locally the conditions are less optimal. The nominated property hence includes all elements necessary to express its outstanding universal value.

The nominated property furthermore comprises almost the entire Wadden Sea ecosystem and is hence of adequate size to ensure the complete representation and conservation of its essential features and processes which maintain its unique character and outstanding universal value.

The property is subject to a comprehensive ecosystem protection and management. It enjoys the highest protection status according to national nature protection legislation in the two countries. The entire German part of the property has been designated as national parks since the mid 1980s, and the Dutch part is subject to a national planning decree, which stipulates protection in conjunction with sustainable use of the Wadden ecosystem. Furthermore, the property is subject to protection under the European Union environment legislation, which has been transposed into national legislation. As a result of the designations under to the EC Birds and Habitats Directives the property is part of the European Natura 2000 network of protected areas.

Measures taken under to the EC Habitats Directive are directed at maintaining and restoring habitats and species at a favourable conservation status. The EC Habitats Directive, Article 6 (3) further stipulates that: "[A]ny plan or project .....likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives.....[T]he competent national authorities shall agree to the plan or project only after having ascertained

that it will not adversely affect the integrity of the site." Article 6 (4) of the Directive stipulates that a plan or project, that will adversely affect the site, will only be permitted for imperative reasons of overriding public interest and in the absence of alternatives and only in combination with compensatory measures. It is worthwhile emphasizing these provisions because they legally codify that a prime objective is to maintain and advance the integrity of the site in terms of the sites conservation objectives.

Most of the Wadden Sea property has been designated as a natural water body. The EU Water Framework Directive applies to the Wadden Sea and will help ensure the maintenance of its sound ecological status by 2015. It is expected that the forthcoming Marine Strategy Directive will help to underpin the measures taken according to the foregoing EU Directives.

In addition to these designations the Wadden Sea is further subject to designation as a Wetland of International Importance under the Ramsar Convention and as a UNESCO Man and Biosphere Reserves. This constitutes a further international recognition of the nominated Site's international significance.

Since the 1970s the three Wadden Sea countries have cooperated in the protection of the Wadden Sea as one shared ecosystem. The guiding principle of the Wadden Sea policy and management as formulated in the Wadden Sea Plan is to achieve and maintain, as far as possible, a natural and sustainable ecosystem in which natural processes proceed in an undisturbed way. The policy and management measures are directed at towards maintaining the full-scale of habitat types, which belong to a natural and dynamic Wadden Sea. Environmental standards have been set for each of these habitats in respect to natural dynamics, absence of disturbance, and absence of pollution, which can be reached by proper conservation and management arrangements. The quality of the habitats shall then be maintained or improved by working towards achieving specified environmental targets for habitat types, concerning the quality of water and sediment, and for the conservation of birds and marine mammals. The common policies and management in relation to the specified targets are further specified in the Wadden Sea Plan 1997 which is currently being further developed.

The pollution resulting from the input of nutrients and hazardous substances has been significantly reduced in the past 10 years. Further measures will be taken according to existing and proposed legal instruments designed to achieve specified targets and to maintain a sound ecological status by 2015. The pollution resulting from operational discharges from shipping has likewise been reduced under the designation of the North Sea, including the Wadden Sea, as a Special Sea Area according to MARPOL, Annex I, II and V, and is reinforced by an extensive monitoring of any operational discharges. Shipping safety has been significantly enhanced during the last 10 years by the designation of traffic separation schemes in conjunction with the designation of the Wadden Sea as a Particularly Sensitive Sea Area (PSSA). Extensive contingency plans, including transboundary cooperation, are in place to deal with ship accidents.

The legal protection and the management of the property also aim to maintain the landscape values of the property such as the wide-open horizon. Infrastructure projects within the property are therefore to a wide extent banned. In the case of wind turbines there is a complete ban on the construction of such installations in the nominated area.

Anthropogenic influences are well regulated and a set of eco-targets has been agreed upon in 1994 and internationally based on the Esbjerg declaration. All resource use and other uses of the Wadden Sea have been regulated under a wide variety of legal measure that form the framework for protection of the area and through the overall high standards of the management system. All resource activities that have not been banned are subject to assessment and licensing in accordance with European legislation, including oil and gas development. It should be acknowledged that these assessments are applied to all activities and projects within and outside the property that may have a significant effect.

Some activities have been fully banned within the property such a mechanical cockle fishery and extraction of sand for commercial purposes. Certain areas have been designated as zero use or scientific reference areas where basically all resource use is prohibited, for example, no-take zones for the mussel fishery. They serve monitoring and research and form basic tools for the study of trends and support the maintenance of the integrity of the nominated property. Zoning is applied on a permanent or seasonal basis to regulate activities that could disturb birds and seals during critical periods of their lifecycle. Hunting is banned within the property with the exception of some of the inhabited islands where it is allowed, but heavily regulated, for a very short

period. Exemptions for wildlife management and pest control are possible.

Acceleration of sea level rise is a relatively new phenomenon that might potentially have a significant impact on the Wadden Sea in the coming centuries. The precise response of the Wadden Sea system, however, will depend to a large extent on local conditions and on the configuration of the tidal basins. Tidal flats and salt marshes are expected to be able to keep up with sea level rise due to faster sedimentation, at least up to a critical rate.

The safety of the inhabitants from flooding through appropriate coastal protection measures is and will be guaranteed in the future. Such measures have not and will not be compromised by the protection and management schemes. Other measures that are necessary for the safety of the area such as maritime traffic regulation infrastructure, the traffic within the area, drainage of the hinterland, public transport and the delivery of goods to the islands have and will be given priority in relation to the protection and management of the nominated Site.

The introduction of exotic species through the discharge of ballast water and aquaculture is a growing problem throughout the world. Controls are in place to minimise the introduction of exotic species, to monitor their effect, and to adjust quality standards and management measures in order to conserve present species assemblages. No species can be introduced into the nominated property e.g. for aquaculture without an assessment according to the Habitats Directive. Of some 52 known introduced species only six are considered to have a potentially strong effect on the composition of the existing biota in the Wadden Sea. These include: Cordgrass (*Spartina anglica),* Japanese seaweed *(Sargassum muticum),* Bristle Worm *(Marenzelleria cf. viridisi),* American razor clam *(Ensis americanus),* American slipper limpet *(Crepidula fornicata),* and Pacific oyster (*Crassotrea gigas).* These species differ in their effects, some of which may be of a dynamic character (*i.e.*, sediment retention by *Spartina*, habitat provision by *Sargassum*, more food for birds by *Ensis* displacement of seagrass by *Spartina*, competition to mussels by *Crassostrea*). Global warming may benefit *Spartina, Crepidula* and *Crassostrea,* resulting in changes in their dominance. Some introductions have become extremely numerous locally and then declined again, such as the bristle worm *Marenzelleria*. Its native biota has, however, had a long history of context with immigrants.

In terms of harmonized international and national policies, management arrangements, and integrated environmental monitoring and assessment processes the Wadden Sea now after a generation of continued efforts enjoys a level of environmental protection and wise management that is unprecedented throughout Europe and other parts of the World. The current protection and management measures are designed to guarantee the sustainable use of the property and the integrity of the system including the ecological processes that maintain it.

Sandy tidal flats
(Photo: Martin Stock).

4. STATE OF CONSERVATION AND FACTORS AFFECTING THE PROPERTY

4.a Present state of conservation

Information on status and developments in the Wadden Sea is compiled and assessed in regular Quality Status Reports which have the aim of assessing the implementation of the Wadden Sea Plan and providing a scientific assessment of the entire ecosystem. The recent Quality Status Report (QSR 2004) was published in preparation for the Trilateral Governmental Conference in 2005. The information in this chapter is based on the QSR 2004, supplemented with information that has become available since the QSR 2004 was issued.

The Wadden Sea Quality Status Report (QSR) 1999 is in **Annex 07** and the Wadden Sea Quality Status Report (QSR) 2004 is in **Annex 08**, both as separate volumes.

Habitats and habitat developments

Offshore area

The Wadden Sea Plan aims for an increased natural morphology and favourable conditions for birds and marine mammals in the offshore area. The offshore area in the nominated property is located off the Wadden islands of the German part and extends up to 12 nautical miles into the North Sea to a water depth of 10 to 20 m. The area is subject to nature conservation under national and EU legislation.

The offshore area is characterized by high natural dynamics and is interlinked with the Wadden Sea ecosystem (see Chapter 2). The sediments of the seabed of the offshore area and of the channels and tidal flats in the Wadden Sea form a coherent 'sand sharing' system, thus allowing natural sediment transport along the coast and into the Wadden Sea. There is no evidence of any negative impacts on the natural dynamics of the geomorphology in the offshore area.

Birds

In the Wadden Sea offshore area, nine coastal bird species occur in numbers which are of international importance (Tab 4.1). Many of these coastal birds use the offshore area as foraging areas, such as the sandwich tern (*Sterna sandvicensis*) which feeds on sand eel up to 15 km from the breeding colonies, and the great black-backed gull (*Larus marinus*).

Off the North Frisian islands (at water depths of 2 - 10 m), large concentrations of common scoter (*Melanitta nigra)* occur, most of which leave from there for their northern breeding grounds.

Among the marine bird species, guillemot (*Uria aalga*) and razorbill (*Alca torda*) occur in areas

Table 4.1: Estimated numbers of the most numerous coastal bird species occurring in the offshore area up to the 20 m water depth line in specific months of the year. * Number of international importance; 1% level (source: QSR 2004).

Species	1% level of flyway	Period	Estimated number	Number in % of total population
Red/Black-throated diver	10,000	Dec-Mar	36,000*	4
Eider	10,300	Oct-Feb	63,000*	6
Common scoter	16,000	Dec-Feb	303,000*	19
Velvet scoter	10,000	Dec-Feb	7,000	< 1
Little gull	840	Mar-May	2,500*	3
Common gull	17,000	Dec-Feb	67,000*	4
Lesser black-backed gull	1,900	May-June	50,000*	26
Herring gull	13,000	Nov-Feb	48,000*	4
Sandwich tern	1,700	Apr-May	13,000*	8
Common tern	1,900	Apr-May	4,000*	2

with water depths larger 10 m all over the entire North Sea in numbers of 2,000 – 3,000 individuals, but also use the coastal zone. The most common diver, the red-throated diver (*Gavia stellata*), occurs with about 36,000 individuals in the offshore area between the 4-26 m depth line.

Marine mammals

The offshore area is also an important area for marine mammals. Recent surveys indicated that harbour seals use the offshore area and the adjacent North Sea to a larger extent than known before. Harbour porpoises are distributed over the entire North Sea but show significantly high densities off the coast of Schleswig-Holstein within and outside the nominated property. The offshore area of the nominated property off the islands of Sylt and Amrum has specifically been designated as a whale protection area and extends up to 12 nautical miles.

Creek system on tidal flats (Photo: Klaus Janke).

Tidal area

The tidal area between the mainland and the islands covers the intertidal flats and the subtidal areas and is characterized by a high degree of natural dynamics: the positions and structures of tidal channels, shoals and emerging sand banks are changing continuously. The entire tidal area is subject to nature conservation by national and EU legislation. It is also covered by the trilateral Wadden Sea Plan, which aims for a natural dynamic situation and increased geomorphologically and biologically undisturbed areas in the tidal area. In addition, targets for blue mussel beds, seagrass beds and Sabellaria reefs have been formulated.

The tidal area in the Netherlands and Germany has a total size of about 6400 km², of which about 4700 km² consists of intertidal flats (mud and sand flats). The total area of the intertidal flats is almost the same as in the mid 1980s. Since then, no further embankments have been carried out. However, there seems to be a general depletion of fine-grained material close to the mainland coast due to hydromorphological changes as a combined result of land reclamations in historic times (since 1600) and sea level rise.

Seagrass

The two seagrass species (*Zostera marina* and *Z. noltii*) are the only submersed flowering plants in the Wadden Sea. They provide habitat for various animals and food for brent geese and widgeon. The trilateral Wadden Sea Plan aims for an increased area and a more natural distribution and development of seagrass fields.

Subtidal seagrass beds of *Zostera marina* disappeared in the 1930s because of a disease (an infestation with the pathogenic protist *Labyrinthula zosterae*). A decline of intertidal seagrass (*Z. marina* and *Z. noltii*) was observed from the 1950s

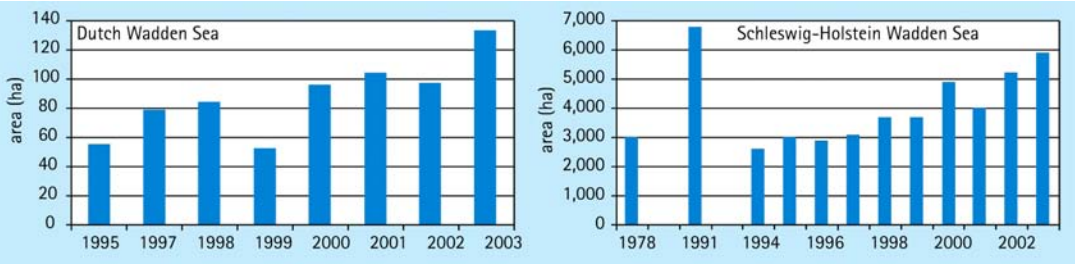


Figure 4.1: Area of seagrass in ha on intertidal flats in the Dutch Wadden Sea (seagrass bed coverage >5%) and the northern Schleswig-Holstein Wadden Sea (seagrass bed coverage >20%) (note the different x and y axes) (QSR 2004).

to the 1990s in the southern and central Wadden Sea. This decline seems to have come to a halt, and some slow recovery is evident. In the Netherlands, about 130 ha is observed, located mainly in the Ems-Dollard. In Niedersachsen, a complete survey in 2002 revealed a total area of 750 ha (with a main occurrence of 580 ha in the Jade Bay).

Today, intertidal seagrass beds are unevenly distributed with a major occurrence (over 80%) in the northern Schleswig-Holstein Wadden Sea (about 6000 ha), because the decline was more prominent in the western parts of the Wadden Sea. Both *Zostera* species also show considerable fluctuations between years in the size and shape of local beds.

Eutrophication and changing hydrodynamics seem to be the overall variables determining seagrass distribution in the Wadden Sea, while positive effects of low salinity and negative effects of shellfish fishery and coastal protection works are of an important but more local relevance.

Mussel beds

Blue mussel beds are subject to particular protection because of their biodiversity and special ecological significance. Therefore, fishery is regulated by management plans in the entire Wadden Sea (see chapter: resources / management). The trilateral Wadden Sea Plan aims for an increased area and a more natural distribution and development of natural blue mussel beds.

Naturally occurring blue mussel beds have thus been able to develop in the intertidal (Fig. 4.2). However, lack of recruitment since 1999 has caused deterioration and overall loss of biomass.

Spatfall is a crucial process in the population dynamics of blue mussels. The determining factors for spatfall are still not well understood, nor is the cause of regional differences in spatfall within the Wadden Sea.

Besides recruitment success, the impact of storms and ice cover is of major importance for the long-term development of blue mussel beds.

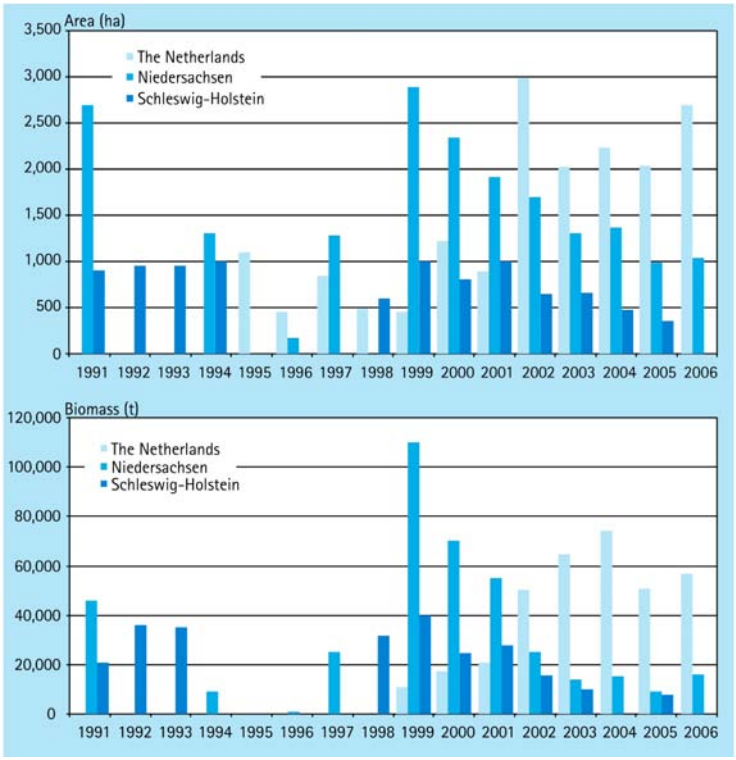


Figure 4.2: Area (ha) and biomass (t) of intertidal blue mussel beds in the Netherlands and Germany (Niedersachsen, Schleswig-Holstein), (no bars = no data).

Salt marsh
(Photo: Klaas Kreuijer).

Salt marshes

Salt marshes are the natural link between the land and the sea. They develop in close interaction between hydrodynamic processes and vegetation development. Salt marshes can be found on the barrier islands and Halligen, in the estuaries and along the mainland coast. During the last centuries, many salt marshes along the mainland coast were reclaimed, with subsequent creation of new salt marshes in front of the dikes, or were intensively grazed by cattle or sheep. Today, all Wadden Sea salt marshes are subject to nature conservation schemes by national and EU legislation, and they are also covered by the Wadden Sea Plan. The Wadden Sea Plan aims at an increased area of natural salt marshes, natural morphology and dynamics and an improved natural vegetation structure of man-made salt marshes.

The salt marsh area increased in most parts of the Wadden Sea during the past decades, mainly on the eastern parts of islands and in sheltered areas along the coast. The main increases were observed in Niedersachsen (about 2700 ha, 1966 – 1997) and in Schleswig-Holstein (about 700 ha, 1988 – 2001). The recent comprehensive inventory of all salt marshes based on regular complete vegetation mapping resulted in a total area of 31,070 ha in the nominated property (QSR 2004).

In the Netherlands and Germany, roughly 56% of the salt marshes on the islands and roughly 7% of the salt marshes on the mainland have never been artificially drained and are not grazed by livestock and thus can be regarded as natural. In addition, about 690 ha of salt marshes (310 in Niedersachsen and 340 in the Netherlands) have been de-embanked, and the possible development

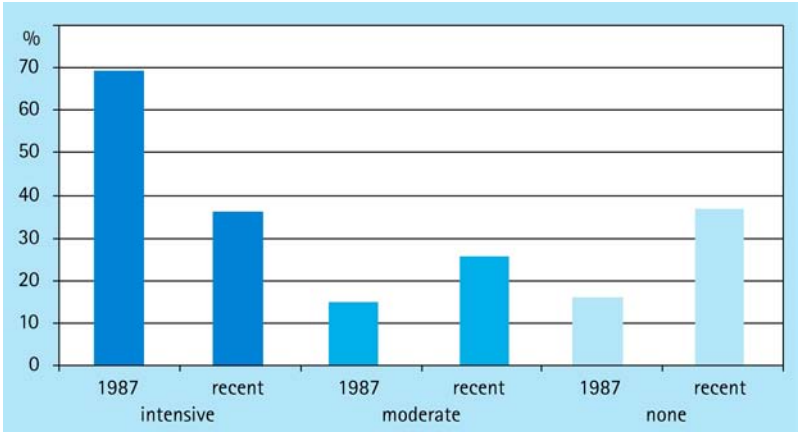


Figure 4.3:
Intensity of grazing by livestock on mainland salt marshes in the Wadden Sea (agricultural use and nature management) (Data source: TMAP and QSR 2004).

of new salt marsh areas and vegetation development are being monitored.

Since the 1980s, livestock grazing and artificial drainage for costal protection or agricultural utilization has generally been reduced. In some cases, moderate grazing is carried out for biodiversity purposes or to gain sod for coastal protection measures. Many natural and semi-natural salt marsh areas have developed during these last two decades. On the islands, the majority of the salt marshes can develop naturally and show various transition stages. Livestock grazing for agricultural purposes has generally decreased in all areas during the past 20 years. In about 60% of the salt marshes no drainage measures have been taken at all, and in an additional 31% no artificial drainage measures have been carried out during the past 10 years.

The salt marshes along the mainland coast are normally situated in front of the sea dike. In most cases their development has been actively supported by man, for example by drainage or reduction of wave energy. In former times, many of them were intensively used for agricultural purposes. Since the mid 1980s, a reduction of 50% of areas with intensive grazing could be observed on the mainland salt marshes in the Netherlands and Germany (Figure 4.3). In about 39% of the mainland salt marshes, no drainage measures have been taken during the past 10 years. This has enhanced natural sedimentation and erosion processes and the development of natural salt marsh vegetation.

The salt marsh vegetation development is monitored by using a trilaterally harmonized vegetation key, which allows a consistent and detailed analysis of the salt marsh vegetation with regard to the Wadden Sea Plan Targets. This also entails an assessment of vegetation changes as a result of changes in management, sea level rise, and spreading of single species such as *Spartina anglica, Atriplex prostata, Elytrigia atherica, Elytrigia repens* and *Phragmites australis*.

Beaches and dunes

Beaches and dunes are subject to constant changes as a result of natural forces such the North Sea currents, waves, and wind. About 4600 ha of dunes are located in the nominated property, with the majority on the islands of Niedersachsen. They represent the typical Wadden Sea barrier island.

Almost all beaches and dunes areas are subject to nature conservation under national and EU legislation and covered by the Wadden Sea Plan, which aims for an increased natural dynamic and vegetation succession.

Natural dynamics of beaches and dunes can be observed mainly in the eastern, uninhabited parts of the barrier islands where no coastal protection measures have to be carried out. Large beach plains as well as embryonic and primary dunes have developed in these areas as result of natural sand transport. Since the mid 1960s, about 870 ha of new dune areas have developed; at the same time, an erosion of 115 ha of dunes occurred.

In the western, inhabited parts of the islands, however, practically all dunes are an integrated part of the coastal defence system. The white dunes are maintained and protected from erosion, e.g. by planting of marram grass. In these areas, natural dynamics of beaches are locally and periodically influenced by coastal protection measures, e.g. in the form of stony groins and sand nourishment of the beach or foreshore. Coastal protection measures may increase in connection with continued sea level rise. Additionally, the beaches adjacent to the island villages are also main areas of recreational activities.

The development of the dunes on the Niedersachsen back barrier islands over a period of 50 years was analyzed by comparison of various vegetation maps from the 1940s with recent surveys:

- Embryonic dunes naturally develop on the beaches of the eastern parts of the islands, whereas they have decreased in areas with intensive recreational use;
- The area of white dunes has almost remained unchanged, also because of their importance for coastal defence;
- Grey dunes continue to represent the major dune type and a development in the direction of older successional stages such as heath or brushwood was observed;
- Species-rich dune slacks represent a rare but important dune type with a specific vegetation and biodiversity. On some islands, an accelerated succession of dune slacks to drier communities is caused by enhanced groundwater extraction. Therefore, a management scheme was established on the islands of Langeoog and Norderney to minimize the impact of groundwater extraction on vegetation.

Similar developments were also observed in dune areas adjacent to the nominated property, e.g. on the Dutch and Schleswig-Holstein islands.

Species and population trends and developments

Birds

Breeding birds

Many bird species breed on the Wadden Sea salt marshes, dunes and beaches. During this time they are particularly vulnerable. All bird species are protected under national and EU legislation. The trilateral Wadden Sea Plan aims at favourable conditions for breeding birds through favourable food availability and natural breeding success.

Among the 31 bird species regularly monitored in the Trilateral Monitoring and Assessment Program (TMAP), there are five species which occur with more than 25% of the NW European populations breeding in the Wadden Sea. Some species are rare, as the Wadden Sea is situated on the edge of their European breeding range.

The quality of various habitats has improved in recent decades, leading for instance to an increase in numbers of coastal birds such as the common redshank breeding on salt marshes. Thanks to nearly 15 years of monitoring (since 1994), a reliable evaluation of trends has become possible, both for the entire period as well as for the last five years. The latter can be used as an alert for recent changes (Tab. 4.2).

Table 4.2:
Breeding birds in the Wadden Sea in 2001 and trends in 1990–2001 (Koffijberg et al., 2006.). Also given are international importance (expressed as percentage of the overall NW-European flyway population, after Rasmussen et al.,2000) and Red List status (Wadden Sea, SUS susceptible; VUL vulnerable; END Endangered; CRI critical; - no red list status, according to Rasmussen et al., 1996). 2001 refers to the breeding population in 2001. Trends are shown for the entire period 1991–2001 and for the last 5 years (since 1996) to detect recent changes: - significant decrease; = significantly stable; (=) fluctuating without significant trend; + significant increase (significant at $P < 0.05$). For some species, no trend could be calculated due to the small or scattered breeding population ('no data'). Species included in Annex I of the EC Birds Directive are marked separately.
[1] trend calculation was not possible due to lack of data; classification is based on the results of the surveys in 1991, 1996 and 2001.

Species	Annex I EC Birds Directive	% population NW-Europe	Red List Status	2001	Trend 1990–2001	Trend 1996–2001
Great cormorant *Phalacrocorax carbo*	-	1-5	-	2,348	+	+
Eurasian spoonbill *Platalea leucorodia*	x	>25	SUS	831	+	+
Shelduck *Tadorna tadorna**	-	5-25	-	6,480	+	+
Common eider *Somateria mollissima**	-	1-5	-	10,500	+	(=)
Red-breasted merganser *Mergus serrator*	-	<1	VUL	44	(+)	no data
Hen harrier *Circus cyaneus*	x	1-5	-	126	(=)	-
Oystercatcher *Haematopus ostralegus**	-	5-25	-	39,928	(=)	-
Avocet *Recurvirostra avosetta**	x	>25	-	10,170	=	(=)
Great ringed plover *Charadrius hiaticula**	-	1-5	VUL	1,093	-	-
Kentish plover *Charadrius alexandrinus**	x	>25	END	340	-	-
Northern lapwing *Vanellus vanellus**	-	1-5	-	11,643	-	(=)
Dunlin *Calidris alpina schinzii*	x	1-5	CRI	24	(-)[1]	no data
Ruff *Philomachus pugnax*	x	<1	CRI	33	(-)[1]	no data
Common snipe *Gallinago gallinago*	-	<1	-	188	(-)[1]	no data
Black-tailed godwit *Limosa limosa*	-	1-5	VUL	2,824	-	(=)
Eurasian curlew *Numenius arquata*	-	<1	-	640	(=)	(=)
Common redshank *Tringa totanus**	-	5-25	-	17,815	(=)	(=)
Turnstone *Arenaria interpres*	-	<1	CRI	1	no data	no data
Mediterranean gull *Larus melanocephalus*	x	1-5	-	9	+	+
Little gull *Larus minutus*	x	<1	SUS	-	no data	no data
Black-headed gull *Larus ridibundus**	-	5-25	-	154,395	(=)	+
Common gull *Larus canus**	-	1-5	-	13,827	+	+
Lesser black-backed gull *Larus fuscus**	-	5-25	-	79,679	+	+
Herring gull *Larus argentatus**	-	5-25	-	78,402	-	(=)
Great black-backed gull *Larus marinus*	-	<1	-	27	+	+
Gull-billed tern *Gelochelidon nilotica*	x	>25	CRI	56	(=)	(=)
Sandwich tern *Sterna sandvichensis**	x	>25	END	17,172	=	(=)
Common tern *Sterna hirundo**	x	5-25	-	13,594	-	+
Arctic tern *Sterna paradisaea**	x	1-5	-	8,464	+	-
Little tern *Sterna albifrons*	x	>25	END	1,099	+	+
Short-eared owl *Asio flammeus*	x	<1	END	89	(=)	(=)

Bar-tailed godwit (Photo: Jan van de Kam).

Over the period 1990-2001 and considering the entire Wadden Sea, ten species increased significantly. The highest rates of increase are observed for the great cormorant, great black-backed gull, Eurasian spoonbill, lesser black-backed gull and Mediterranean gull (Tab 4.2). Nearly all of these species have expanded their geographical breeding range in the past decade and showed further increases in 2002-2004. The breeding population of most increasing species continued to grow during the entire period covered by the surveys (see Tab. 4.2). For common eider and arctic tern, a decreasing trend was observed if only the years from 1996 and 1998 are considered, respectively.

Significant declines have occurred in nine species, among them the great ringed plover, Kentish plover, black-tailed godwit and northern lapwing. The most dramatic declines seem to have occurred in three species for which proper trend calculations in the past decade are difficult to assess due to low numbers and scattered breeding (dunlin, ruff, common snipe). Recent counts (up to 2004) suggest that the rate of decline of the northern lapwing, black-tailed godwit and herring gull has levelled off, whereas a recovery has recently become apparent for the common tern. The great ringed plover and Kentish plover continued to decline in 2002-2004.

The decline in numbers of some species has been caused by increased recreational pressure on beaches and other breeding habitats. Protective measures for beach-breeding birds have been successful for the colony-breeding little tern, but Kentish plover and great ringed plover show an ongoing decline and need further protection effort. The decline in breeding populations of common eider (>75% in the Dutch Wadden Sea), oystercatchers and, probably, also herring gull, mainly in the Dutch Wadden Sea, was considered as an effect of intense shellfish fisheries (cockle and blue mussels), which has now been reduced in the Netherlands. In some areas, shifts in breeding numbers from the mainland coast to the islands were observed, caused by increasing predation pressure by mammalian predators, e.g. the red fox. For species breeding in salt marshes (e.g., waders, passerines) various trends and fluctuations have been observed, however, without a clear relationship with changes in agricultural use or vegetation development of these areas.

Migratory birds

The outstanding importance of the Wadden Sea for migratory birds has been acknowledged in several international conventions and directives, such as the Ramsar Convention, the Bonn Convention on Migratory Species and the EC Birds and Habitats Directive. These all have been implemented in national legislation and the respective protection regimes. The Wadden Sea Plan aims at favourable conditions for migratory birds and sufficiently large undisturbed roosting and moulting areas.

The amount and quality of data on migratory waterbirds has increased considerably in recent decades. In addition to surveys focusing on wintering numbers and distribution in the framework of the International Waterbird Census of Wetlands International, further synchronous and complete counts and bi-monthly spring-tide counts at numerous sites are carried out in the TMAP. Therefore, for the first time, overall trends of the most important species have been calculated for the entire Wadden Sea, including all months of the year.

The analysis of trends of migratory waterbirds utilizing the Wadden Sea for the period 1992 – 2000 revealed alarming results: 22 out of 34

Table 4.3a: Trend categories for the recent 10 years 1994/1995 – 2003/2004 for the Wadden Sea and the regions (in "trend tables") (after Blew et al., 2007). Trend categories: ++ = strong increase, + = increase, 0 = stable, – = decrease, F=fluctuating.

Species	Wadden Sea	SH	Nds	NL
Eurasian spoonbill	++	++	++	++
Great cormorant	++	++	++	++
Northern pintail	+	0	+	+
Common ringed plover	+	+	+	+
Sanderling	+	F	0	++
Bar-tailed godwit	+	-	0	+
Northern shoveler	0	0	+	0
Common shelduck	0	-	0	+
Barnacle goose	0	0	0	+
Common greenshank	0	-	0	F
Northern lapwing	0	0	0	F
Eurasian curlew	0	-	-	+
Common gull	0	0	F	0
Dunlin	0	-	0	+
Black-headed gull	0	-	0	0
Grey plover	0	-	0	0
Whimbrel	0	F	-	F
Spotted redshank	0	-	0	-
Common redshank	-	-	-	0
Mallard	-	0	0	0
European golden plover	-	-	0	0
European herring gull	-	-	-	-
Eurasian oystercatcher	-	-	-	-
Pied avocet	-	-	0	-
Brent goose	-	-	0	-
Great black-backed gull	-	-	-	F
Eurasian widgeon	-	-	-	F
Red knot	-	-	-	-
Ruff	-	-	F	0
Curlew sandpiper	F	F	F	F
Common teal	F	0	F	F
Ruddy turnstone	F	0	F	0
Kentish plover	F	0	F	F

Table 4.3b: Counts of trend categories for the recent 10 years (1994/1995–2003/2004) in the Wadden Sea (after Blew et al., 2007).

Trend category	Wadden Sea	SH	Nds	NL
Strong decrease	0	0	0	0
Decrease	11	18	8	6
Stable	12	9	14	9
Increase	4	1	3	7
Strong increase	2	2	2	3
Fluctuating / uncertain	4	3	6	8

waterbird species experienced declines, of which 15 are statistically significant.

This trend calculation was updated to cover the recent ten year-period 1994/95 - 2003/04 and highlights the actual developments in the Wadden Sea (Blew et al., in prep). According to these updated results, the situation of 6 waterbird species in the Wadden Sea seems to have improved compared to the 1990s (Tab. 4.3 a). In general, less species showed a decline, however, negative trends for the mussel feeding species and regionally different trends for the most numerous species in the Wadden Sea need to be further assessed.

Most of the declining species were dependent on feeding on benthos, including bivalves, for 'fast refuelling' during their migration to the breeding and wintering areas. This is an indication of non-favourable food availability, although other risk

factors such as wintering in Africa and breeding in the (sub)arctic may play a role. For the bird species within this group and specializing in molluscs (e.g. eider, oystercatcher, knot and herring gull), it has been proven for some parts of the Wadden Sea that food availability was impaired due to shellfish fishery. For herbivorous species (*e.g.*, dark-bellied brent goose, Eurasian widgeon and barnacle goose) food availability seems not to be limited.

The eight species showing negative trends also for a longer period (1987/88 – 2003/04), include brent geese and mallard, with flyway population decreases as well as oystercatcher, knot and herring gull, as shellfish eaters. Also, the negative trends in the Wadden Sea of ruff and pied avocet remain for both periods. The overall negative trend of golden plover seems to be greatly determined by Schleswig-Holstein birds, while in the Netherlands and Niedersachsen the numbers are stable. In general, regional differences in distribution occur for a number of species, the reasons for which have to be further investigated.

In Table 4.3a and 4.3b, a summary of the trend categories for the Wadden Sea Area has been compiled.

High tide roosts are relatively well protected, with more than 80% of these roosts being located within Special Protection Areas. Despite this, disturbances can occur in all parts of the Wadden Sea. A main impact is by outdoor recreation, with peaks during July and August but also, increasingly, in spring and autumn. Potential conflicts are minimized and resolved by spatial and temporal zoning of recreational activities as well as convincing visitor information systems. Different protection schemes for roosting birds are in place along the Wadden Sea.

For three species, important moulting areas exist in the Wadden Sea and offshore zone. Practically the entire northwest European common Shelduck population moult in the southern part of the Schleswig-Holstein Wadden Sea. The National Park Agency responsible has been successful in entering voluntary agreements with different user groups aimed at avoidance of disturbance during the moulting season.

For common scoter, moulting areas are in the offshore zone, decreasing in importance from north to south. A realistic estimate of the numbers moulting in the Wadden Sea area does not, however, exist. Moulting areas are chosen according to the presence of their favoured food resource (e.g., bivalves such as *Spisula* spp.) and low disturbance level.

Marine mammals

The numbers of harbour seals and grey seals have significantly increased during the last decades. Trends for population size of harbour porpoise are not yet known specifically for the Wadden Sea, but sightings have increased in recent years. The harbour porpoise belongs to a North Sea population.

All marine mammals are protected under national and EU legislation. Harbour seals and grey seal are also subject to the Seal Agreement, the harbour porpoise is subject to the ASCOBANS agreement, both are regional agreements of the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention). The Seal Agreement was concluded between the three Wadden Sea countries with the aim to cooperate closely in achieving and maintaining a favourable conservation status for the harbour and grey seal populations in the Wadden Sea.

The Wadden Sea Plan aims at viable stocks and a natural reproduction capacity of harbour seals, grey seals and harbour porpoises.

Grey seals

Grey seals had been extinct in the Wadden Sea area (south-eastern North Sea) for centuries because of hunting. Today, the number of grey seals in the Wadden Sea is growing. In the western Dutch Wadden Sea, the development of the grey seal population since its establishment in the early 1980s has been robust. Surveys during moult (March/April) show an annual increase of 20% on average, amounting to about 1,500 animals counted during the moult in 2005 (Fig. 4.4).

In the Wadden Sea of Schleswig-Holstein, recent grey seal pup production (minimum estimates) was about 30. Surveys in the peak moulting season (early April) counted to about 160

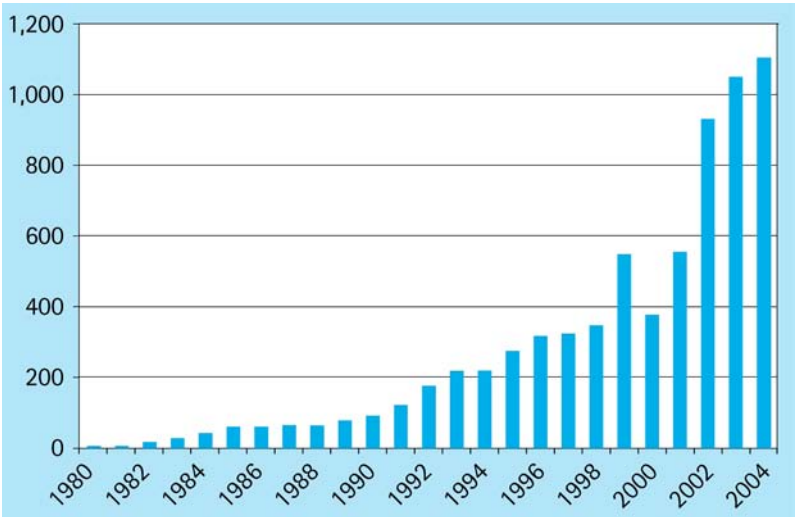


Figure 4.4: Moult counts (March/April) of grey seals in the Dutch Wadden Sea.

grey seals in total. In general, numbers have been increasing by 4–5% per year on average.

Outside the reproductive colonies in the Dutch Wadden Sea and in the Wadden Sea of Schleswig-Holstein, grey seal colonies have established themselves in the Wadden Sea of Niedersachsen (more than 40 grey seals including pups at Borkum Riff in 2005) and on the Dune Isle of Helgoland in the German Bight, where about 150 grey seals were observed in spring 2005.

Harbour seal

The harbour seal (*Phoca vitulina*) is the most numerous native marine mammal species in the Wadden Sea, and its population in the entire Wadden Sea can be considered as an entity. Exchange with populations in other areas such as the Wash (UK) and the Kattegat/Skagerrak (Sweden and Denmark) does occur, however, on a very small scale.

In the Wadden Sea, harbour seals haul out predominantly on intertidal sand banks along the tidal channels, which are emerged during low tide. The sandbanks have a function for social contact, giving birth and nursing the pups and moult.

After a disastrous Phocine Distemper Virus (PDV)-epizootic in 1988, the harbour seal population recovered nearly fivefold, from some 4,400 animals counted in 1989 to 20,975 in 2002 (Fig. 4.5). In 2002, a second PDV-epizootic struck the population, and in 2003, only 47% of the expected number of seals (if no epizootic had occurred) was counted, namely 9654 in the German-Dutch Wadden Sea. This number is comparable to the population count in 1996.

In 2005, the total number of seals counted during coordinated surveys in the moult period in the German-Dutch Wadden Sea in August was 12,555 (5,505 in Schleswig-Holstein, 3,607 in Niedersachsen and 3,443 in the Netherlands). The maximum number of pups counted during the whelping season in June was 4,119 (2,046 in Schleswig-Holstein, 1,176 in Niedersachsen and 897 in the Netherlands). According to recent satellite telemetry investigations, seals use the North Sea to a much larger extent, in terms of numbers as well as range, than thought before.

Harbour porpoise

Harbour porpoises (*Phocoena phocoena*) are widely distributed throughout the North Sea and adjacent waters. They used to be sighted frequently in the big river mouths and in the Wadden Sea.

According to the SCANS surveys in the North Sea and adjacent waters in 1994 and 2005, about 230,000 harbour porpoises were distributed over the entire area of the North Sea. In comparison to other parts of the North Sea, high densities of harbour porpoises and, especially, mother-calf groups were documented for the Schleswig Holstein part. The German area west of Sylt plays an important role as rearing area for harbour porpoises.

Along the Dutch mainland coast, fixed observation sites exist which supply more regular counts. This data demonstrates that since the mid-1990s harbour porpoises are becoming year-round visitors. Mother-calf groups have been observed with increasing regularity and the number of harbour porpoises sighted has increased considerably, by 41% per annum.

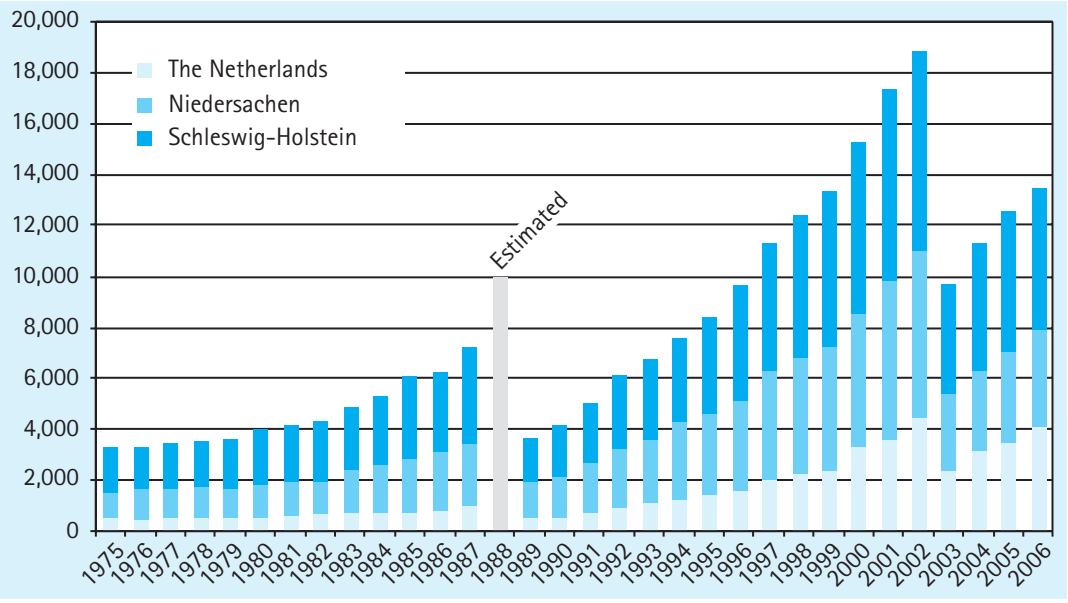


Figure 4.5: Number of harbour seals (*Phoca vitulina*) counted in the different Wadden Sea regions since 1975: The Netherlands, Niedersachsen, and Schleswig-Holstein.

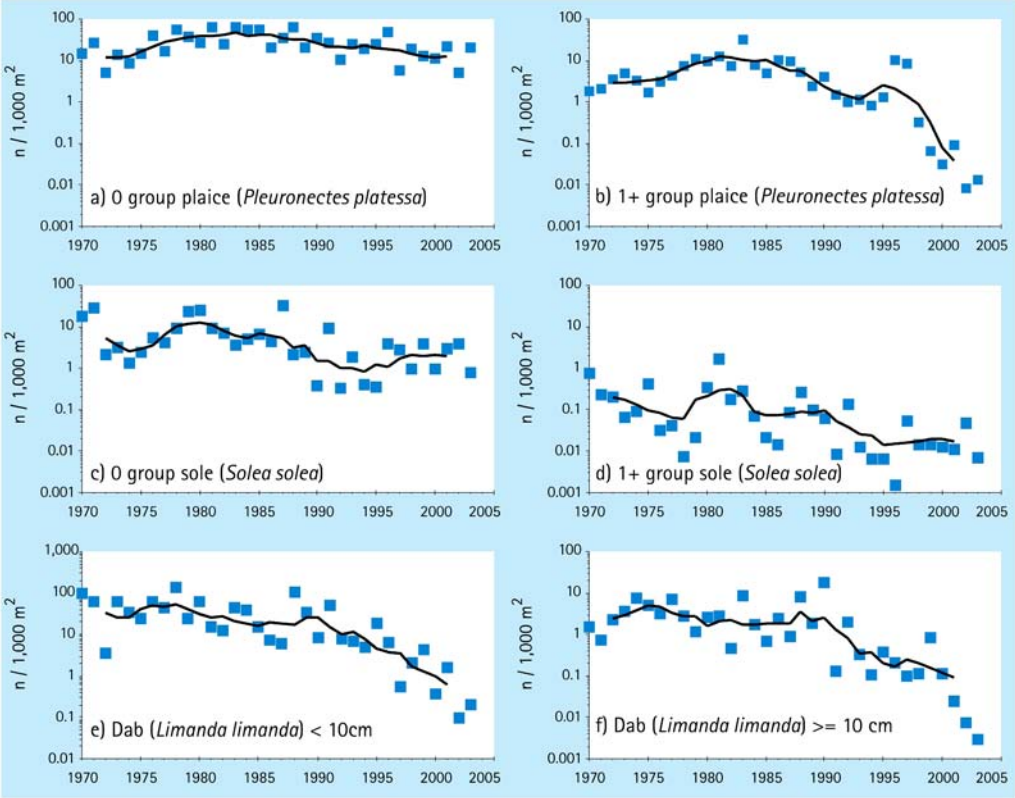


Figure 4.6: Marine juvenile flatfish: Catch rates by age group or size class of plaice (*Pleuronectes platessa*) (a-b), sole (*Solea solea*) (c-d) and dab (*Limanda limanda*) (e-f) in the Dutch Wadden Sea (DFS data): the annual mean (symbols) and the 5-year running mean (solid line).

Aerial surveys of harbour porpoises in the German Bight carried out in the summers of 2002-2006 revealed that the overall mean abundance of harbour porpoises in the German EEZ of the North Sea amounted to around 50,000 animals.

Fish

Fish play an important role in the ecology of the Wadden Sea and the connected estuaries. Protection schemes in the Wadden Sea are established under the Water Framework Directive (transitional waters and rivers) and the Habitats Directive. Fishery management schemes are implemented on the EU level and by national legislation.

Trends on the development of fish populations in the Wadden Sea can be drawn from long-time monitoring series of demersal fish in the Netherlands and Germany (back to the mid 1970s) and on pelagic fish in the Schleswig-Holstein Wadden Sea and some estuaries. The 23 fish species analyzed showed large regional differences in abundance as well as in seasonal distribution. In addition, fluctuations in abundance on larger time scales such as decades occur, which makes it sometimes difficult to detect spatial and regional developments.

Positive trends could be observed for herring, which is in agreement with the North Sea wide distribution pattern, and for anchovy, probably because of increased temperatures. High numbers and an increasing trend of twaite shad were recorded in Schleswig-Holstein (as also recorded in the German Bight), possibly from a stable spawning population in the Elbe estuary. Lower numbers were observed in the Ems estuary.

The numbers of juvenile flatfish using the Dutch Wadden Sea as a nursery area are declining, in particular the abundance of dab and plaice (Fig. 4.6). This is mainly caused by an offshore shift in the distribution of juvenile flatfish and is not related to local environmental changes in the Wadden Sea; the causal factors for this shift are not yet fully understood.

Five bearded rockling or hooknose, classified as (near) resident species, do not show any clear trends in abundance over longer time periods. The abundance of the true resident species bull rout and eelpout seem to fluctuate on a decadal scale (Fig. 4.7).

Macrozoobenthos

The benthic macrofauna communities play a key role in the Wadden Sea food web. They are characteristic species of several habitat types under the Habitats Directive and are included as biological quality element in the Water Framework Directive.

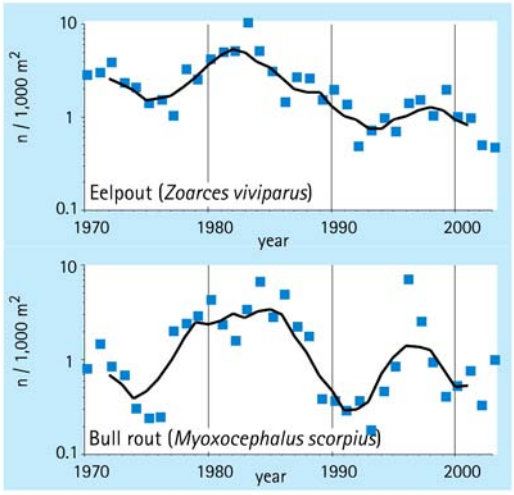


Figure 4.7: Resident species: Catch rates of eelpout (*Zoarces viviparus*) (a) and bull rout (*Myoxocephalus scorpius*) (b) in the Dutch Wadden Sea (DFS-data): the annual mean (symbols) and the 5-year running mean (solid line).

Long-term data sets back to the 1970s reveal large fluctuations in macrozoobenthos biomass and species abundances in different parts of the Wadden Sea. However, two opposite trends were observed: biomass of polychaete worms increased, whereas bivalve biomass declined. The reasons for these trends are not known yet. The observed decline in bivalve recruitment success over approximately the last 15 years, which was accompanied by a shoreward shift of their centres of distribution, may be explained largely by increasing predation pressure on the newly settled post-larvae by shrimps and shore crabs. This effect has been observed in different parts of the Wadden Sea and coincides with the occurrence of mild winters. This indicates the influence of climatic factors in governing recruitment, and therefore population sizes, of bivalves in the Wadden Sea. On a more regional scale, changes in sediment conditions may also play a role.

Changes in the composition of macrozoobenthos communities have been observed due to invasions of new species during the last century, such as the American razor clam (*Ensis americanus*) the American slipper limpet (*Crepidula fernicata*) and the estuarine polychaete worm *Marenzellaria* cf *wireni*. So far, these newcomers were integrated in the Wadden Sea ecosystem without any negative effects. It is yet unclear in which way the newly spread pacific oyster (*Crassostrea gigas*) will influence the ecology of the tidal flats, for example, by invading blue mussel bed habitats or influencing the food supply of mussel-eating birds.

In the northern German Wadden Sea, some 100 species were common in the first half of the 20th century. Of these, 28 have decreased considerably in abundance, mainly because of the disappearance of natural oyster beds and reefs of the tube building polychaete *Sabellaria spinulosa*. Other species increased in abundance, especially a number of polychaetes adapted to disturbed habitats.

4.b Factors affecting the property

(i) Development pressures

All human activities within the nominated property which are assessed to cause adverse effect are regulated in time and space or, as appropriate, prohibited. All activities that are allowed are subject to licensing following an assessment of their impact on the property in accordance with the stipulations of Art. 6 of the Habitats Directive, implemented by German and Dutch law. Art. 6 (3) of the Habitats Directive stipulates, as mentioned in Chapter 3, that "[A]ny plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. ..[t]he competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned ..." Henceforth, subsection 4 of the directive stipulates that "[I]f, in spite of a negative assessment of the implications for the site and in the absence of alternative solutions, a plan or project must nevertheless be carried out for imperative reasons of overriding public interest, including those of a social or economic nature, the Member State shall take all compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected...". Thus within the framework of the approval procedures standardized preconditions have to be fulfilled obligatory. This includes relevant national nature protection regulations according to the Dutch Nature Conservation Act (1998), the PKB, the German National park acts, the Federal and states Nature Conservation Acts, as well as relevant EU Directives and other international regulations (e. g. PSSA, OSPAR, AEWA, MARPOL, RAMSAR-Agreement and Bonn-Agreement), the Wadden Sea Plan and other trilateral agreements.

Furthermore, in addition to the Targets, the Wadden Sea Plan also encompasses a number of Shared Principles which are fundamental to decisions concerning the protection and manage-

ment of the Wadden Sea. The result is that the nominated property is not subject to significant development pressures.

There are, however, a number of activities, the most prominent ones taking place outside the nominated property, that potentially affect it but are essential for the regional economy and the living conditions of the people living in the area or visiting it as tourists. These activities are shipping and the related (maintenance) dredging of the shipping routes and harbour developments, subsidence resulting from gas extraction and coastal protection. Further, the issue of introduced species is a potential pressure to address. Additionally, there are some activities such as civil air traffic, military activities, hunting and laying of cables that may potentially cause disturbance to the nominated property.

In many of these activities the natural dynamic processes which change the Wadden Sea over time have to be taken into account; eg. natural gullies used as shipping routes have moved substantially in the coarse of the centuries. Over the long run, the borders of the nominated area should reflect this dynamic. Minor modifications to the boundaries of the property in case of morphodynamic shifts will be dealt with in accordance with the Operational Guidelines.

Harbors, industrial facilities and dredging

There are many harbours located adjacent to the nominated property. The large majority of the smaller ports are located directly adjacent to the nominated property on the mainland or on the islands. They are vital infrastructure installations for the local and regional economy in terms of, in particular, the supply of the islands, the mainland and the maritime installations and the traffic to and from the islands. Furthermore, there are several major seaports of international significance adjacent to or in the vicinity of the nominated property, which are of significant economic importance both on the regional and the national/international level.

An appropriate sustainable and flexible access to the harbours now and in the future is hence indispensable, as well as navigation, maintenance and development of the fairway . As in the entire Wadden Sea the hydromorphological and geomorphological conditions are highly dynamic and additionally very sensitive to climate change with its sea level rise and variations in storminess i.e. this will have to be considered when thinking about line management of shipways with their river measures like training walls, groins and replacement respectively relocation areas beside the fairway area itself.

Access to the harbours also demands an integrated sediment management, both to maintain the shipping routes and to extend existing ones within the dynamic conditions of tidal coastal areas to allow for sustainable state-of-the-art shipping transport.

In the nominated property, new, not yet approved plans for new construction as well as for the extension or major modification of existing harbour and industrial facilities are not allowed unless such is necessary for imperative reasons of overriding public interest and if no alternatives can be found. In specific cases exemptions can be granted in accordance with the stipulations of Art. 6 of the Habitats Directive. Art. 6 (4) implemented in Dutch and German law, stipulates that if no alternatives can be found to an extension and there are imperative reasons of overriding public interest, a project, in this case a harbour (extension) project, can be undertaken provided that it is compensated to ensure the coherence of the site.

The amounts of dredged material dumped into the whole Wadden Sea Area varied between about 9-26 million t/yr (dry weight) during the period 1998 - 2003 (average 14.8 million t/yr) (Figure 4.8). On average, 12.3 million t/yr (dry weight) were dumped into or near the German part of the Wadden Sea, and 1.4 million t into the Dutch part. In both cases these average amounts decreased compared to the average amounts of dumped dredged material in the period 1989-1997.

Because maintenance dredging is the main source of dumped material, the amounts depend mainly on natural variation of sedimentation and resuspension processes. In general, no trend can be observed in the amounts of dredged material dumped. However, since 1999, yearly amounts have decreased in the Elbe, Jade and Weser areas compared to previous years.

Dredging may potentially lead to geomorphological changes or changes in the tidal regime. It is therefore subject to an environmental assessment of its impacts and subsequent licensing in case of extending existing channels or dredging new ones. Several environmental assessment studies have shown, however, that the impact of dredging is limited in time and space because it follows the natural morphological developments. In general, dredged material is dumped into the system again, provided that the dredged material does not exceed certain pollution or so-called ac-

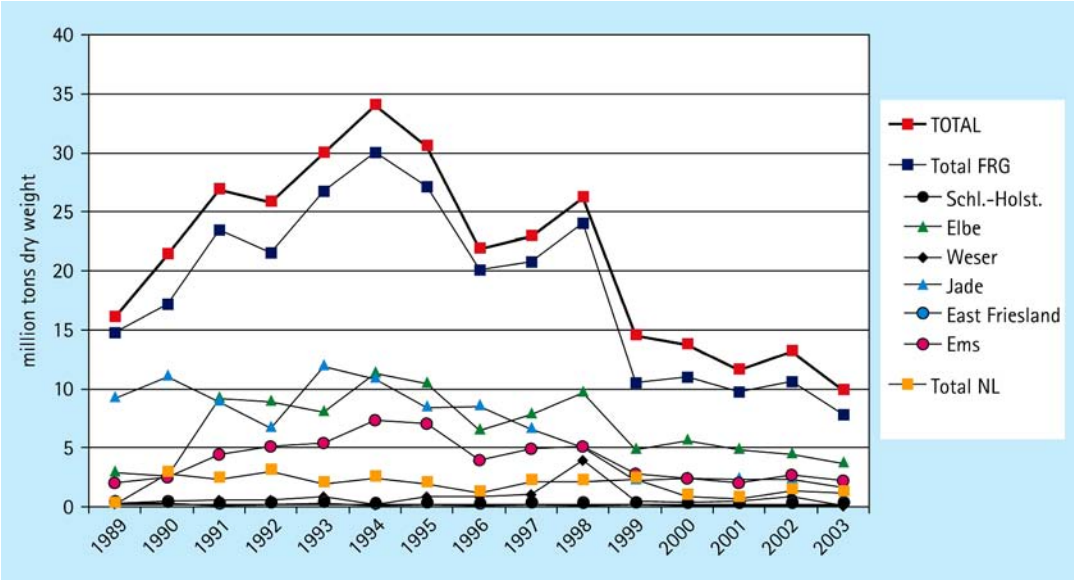


Figure 4.8: Amounts of dumped dredged material in the Wadden Sea (tons dry weight) (period 1989 – 2003). Data source: OSPAR Annual Reports, 1999 QSR. Until 1997 (for NL until 1994), data were reported as tons dry wet weight; for comparison, the figures before 1998 (for NL before 1995) have been converted to dry weight (wet weight/1.97) (after: QSR 2004).

tion levels. For highly polluted dredged material, land based deposition is mandatory. In specific cases dredged material may be used for coastal protection purposes.

The Netherlands intends to enlarge the shipping route from the North Sea towards the Ems harbour. The initiative is related to the plans of a number of energy companies to invest in the harbour area. At present, the bottleneck is the entrance to the harbour which is not deep enough for large ships (Panamax-size). Under specific conditions arising from the EU Directives such as the Water Framework, the Habitats and the Birds Directives as well as from the PKB, the Dutch government will facilitate the deepening to 15.5 meters below 0 and the widening of the waterway to 300 meters on straight sections and to 400 meters in curves. Additional research is needed to estimate effects on coastal defence and the costs and benefits. The Ems-Dollard Treaty between the Netherlands and Germany concerning the estuary will be taken into account for this project. Realisation of the works is foreseen in spring 2010.

The procedure for an Environmental Impact Assessment (EIA) will be followed on a voluntary basis to assess the environmental effects of different alternatives. Parallel to this project, the harbour authorities of Groningen Seaports will also conduct an environmental impact assessment for deepening and enlargement of the Ems harbour.

Currently, there is an application to develop the fairway of the Lower and Outer River Elbe, outside the nominated property, to ensure navigation for vessels with a draught of 14.5 m from the Port of Hamburg. Developments in the size of vessels used in transcontinental traffic make deepening the seaward approach to the Port of Hamburg essential to cope with the rising global flow of goods and to secure Hamburg's position as a logistics hub with a favourable economic and ecological location. To create these improved access conditions, the present fairway outside the nominated property will have to be deepened by between 1.5 m and 2.4 m. A concept for hydraulic engineering is part of the deepening measure. 75% of the dredged sediments will be used for this concept. Key elements are two large-scale underwater structures in the estuary, which directly adjoin the nominated property. The hydrological effect of these structures will be to decrease flow velocities, avoid high water increases, and maintain low-tide water levels. Additionally, a smaller part of the dredged sediments will be relocated in the outer Elbe estuary. According to hydrodynamic modelling results smaller parts of the relocated material may drift. The fairway deepening measure is planned to start in 2009.

For the middle and long-term perspective there is a need for the development and implementation of an integrated concept for the Tidal River Elbe, which aims at a sustainable stabilisation of the tidal river system by managing the river mouth. This might include hydraulic engineering measures. Highest priority will be laid on the modification towards a balanced sediment budget within the coastal area as well as in the river system itself and to sustain both the ecological and economical values of the whole tidal system. To balance the water levels in the Tidal River

Elbe in order to reduce the actual unnatural high incoming tidal energy in the river mouth, it will be necessary to reduce the rate of tidal-pumping sediments river-upwards and flood risk as well. The actual morphological situation cannot be fixed in its presently existing borders. New science-based understanding with the support of hydrodynamic computer models will help to choose the best required measures. It might influence a small part of the nominated property. Within the framework of the approval procedures standardized preconditions have to be fulfilled obligatory. Consequently hydromorphological modifications of the Elbe River mouth, including the shipway with its sustainable sediment management, will be undertaken in accordance with natural dynamic development as much as possible and in compliance with the national laws of future maintenance of the Federal Waterways with its associated constructions as being non contentious.

In the vicinity of the existing Jade industrial area outside the nominated property, plans for the expansion and installation of new industrial plants exist. In detail, these are additional power plant resources, the extension of the refinery capacity, the construction of a holding tank for liquid gas, the construction of additional chemical or petrochemical plants, including the necessary harbour facilities and infrastructure.

In the neighbourhood of an existing industrial area outside the nominated property, the construction of a new container terminal deepwater harbour, the "Jade Weser Port", is planned to start in 2007 in Wilhelmshaven. The area concerned is situated at an industrial centre with an oil refinery, chemical plants and a power plant. The project is intended to meet the projected significant increase in container traffic and trans-shipment in the German harbours and the development towards larger container ships in combination with the ensuing demands in terms of reach-ability of increasing numbers of ocean-going ships and the handling of longer and larger ships at the harbour installations. It is planned that the port will be operational by 2009/10.

In its first phase the project encompasses the embankment of an area of about 360 ha of the Jade outside the nominated property, of which 120 ha is projected for the container handling area. The existing shipping lane will be partly relocated to the west of the present site with a view to minimize the tide-dynamic impacts and the future maintenance of the lane. Additional turning space for the ships will be established between the new shipping lane and the quay. The dredged material will be used for the embankment. Further expansion stages are under consideration.

An extensive environmental impact assessment of the project has been carried out. According to an expertise provided by the Federal Waterways Engineering and Research Institute ("Bundesanstalt für Wasserbau – BAW"), the construction of the Jade cross-section resulting from the harbour facilities of the Jade Weser Port will not significantly alter the tidal dynamics within the nominated property, and changes to the sedimentation and erosion situation can virtually be ruled out.

Furthermore, the environmental impact assessment did not confirm fears that the construction of the Jade Weser Port would make the Jade less valuable from the point of view of migrating species, in particular marine mammals. The general rise in the volume of shipping traffic to be anticipated in the southern North Sea and, as part of it, in the Jade may increase the risk of maritime accidents occurring and thus the likelihood of adverse effects on the conservation area, for instance as a result of oil tanker accidents. The enhanced technologies in the safety of ships and the vessel traffic system, especially AIS, which are established in the German Bight and which is the best available technology minimize the risk also for the Jade Port and the Jade shipping lane.

Also outside the nominated property, the enlargement of handling capacities and the construction of a coal power plant close to the harbour of Nordenham are under debate. Southeast of the harbour of Cuxhaven, along the Elbe River, expansions of the existing harbour facilities respectively filling of gaps are planned.

In the PKB, an exemption to the prohibition on the extension of ports into or adjacent to the Wadden Sea is granted for a relocation of the TESO harbour for ferries in Den Helder and a limited extension of marinas on the islands. These exemptions will only be granted if they can fulfil the assessment framework of the PKB. A possible extension of the harbour of Harlingen will preferably be realized inside the dikes. If, in this last case, a scientifically based plan demonstrates that an extension into the nominated property is possible within the assessment framework of the PKB, the government will facilitate this by a partial adjustment of the PKB.

Exploration and exploitation of gas and oil

Exploration activities must be authorised in accordance with mining law. They will be executed in compliance with the Dutch Nature Conservation Act (1998), the PKB, the German National Park Acts, Natura 2000, Water Acts and the Wadden Sea Plan (Stade Declaration 1997). Moreover, all international regulations for the protection of the sea and the coasts, e.g. PSSA, OSPAR, AEWA, MARPOL, PARCOM, the Ramsar Convention and the Bonn Convention will be applied.

In Schleswig-Holstein the Wadden Sea Plan is implemented by the National Park Act. Oil exploitation is confined to the existing exploitation site at Mittelplate in the Schleswig-Holstein Wadden Sea. In the Dutch Wadden Sea new exploration and exploitation of gas is only permitted from sites on land and from existing platforms in the North Sea coastal zone outside the nominated property in accordance with the Wadden Sea Plan.

Zuidwal is situated in the western Wadden Sea between Harlingen and Vlieland. The gas is transported to Harlingen by pipeline. An extensive study in 1999 and a report published by the Ministry of Transport and Water Management in 2004 showed that the effects of gas extraction from the Zuidwal site were most likely very minimal.

The main impact, resulting from the exploitation of gas resources adjacent to and within the nominated property from exploitation sites outside the Dutch part of the nominated property - with the exception of one location - is subsidence of the bottom. The potential impact due to subsidence has been monitored since 1963 when the production commenced. No loss of natural values have been found. Subsidence of tidal flats was fully compensated by natural sedimentation. Salt marshes are still increasing in height due to sedimentation and until now no other ecological impacts have been found as a slowdown of the aging of these salt marshes. The only visible change in habitat on the island of Ameland outside the nominated property occurred locally in the sense that low dune valleys have become wetter and may become submerged for a significant period of time in winter.

Development of small fields in the Netherlands has clearly reached its peak, and it is expected that most small fields will stop producing in the coming decades. New, land or island based activities, however, will not be excluded, mostly in order to optimize the use of existing infrastructure and knowledge. In this respect, some activities are expected, but no new gas exploration/exploitation installations within the nominated property itself are foreseen.

The overall conclusion is that subsidence is not a problem in the Wadden Sea as long as the rate of subsidence is within the resilience of the system to cope with sea level rise. These natural boundaries were assessed to vary between 3 and 6 mm per year, depending on the size of the tidal basin. The present rate of sea level rise leaves sufficient space to allow for the subsidence in question. Coastal erosion of the island of Ameland due to sea level rise and subsidence is already managed and prevented by beach and coastal nourishment.

Formerly, the crude oil produced at the production site Mittelplate (Schleswig-Holstein part of the Wadden Sea) was transported to Brunsbüttel by three special double hulled tankers. In 2003, plans for a pipeline were approved, which went into operation in 2005. Disturbance of moulting Shelducks has hence been minimized and risks of oil spills basically excluded. Throughout the full operation period of the 'Mittelplate A' a monitoring program has been conducted in order to screen the ecological impact of the drilling site. Until now, no negative effects have been found at the locality or its surroundings. The production facility can be characterized as a "zero-emission unit".

In addition to the already known reserves of oil and natural gas under exploitation, further reserves are assumed to be present in the area of the German Wadden Sea. In as far as public interest demands it, it should in principle be possible in view of a wise use of energy resources to explore and where relevant to exploit the reserves of gas and oil under the Wadden Sea in compliance with the Wadden Sea Plan and relevant nature protection regulations, e.g. the National Park Acts.

On the basis of the current available knowledge, the following reserves are assumed to be present:

In the area of the Ems estuary east of the treaty area with the Netherlands it is in general known that natural gas can be found at the land-sea interface. In the area of the lower Jade and further into the Wadden Sea, oil reserves can be assumed. This is connected with the oil field "Mittelplate". Finally, it is to be assumed with high likelihood that there is oil in the area northwest of Cuxhaven, based on the underground structures.

In addition to the oil deposits already known, and those exploited by the Mittelplate production facility off the coast of Dithmarschen, which - according to monitoring results - does not have severe or longlasting effects for the environment, further considerable deposits of oil, oil chalk and

Brushwood groins against erosion (Photo: Martin Stock).

natural gas are suspected in the Schleswig-Holstein Wadden Sea area. These known or potential deposits are listed below:

- South of the Mittelplate drilling platform as far as the state border in the River Elbe.
- On the crown of the Büsum salt deposit east of Mittelplate as well as on the flanks of the Oldenswort salt deposit, e.g. southwest of Büsum.

At present it is not possible to foresee whether these oil reserves can be exploited completely from drilling locations outside the National Park. Exploration, and possible future exploitation of these deposits, will be carried out in compliance with the Schleswig-Holstein National Park Act.

Exploration and exploitation is to be carried out with the minimum possible interference in the environment and using the best available techniques. They must comply with EC, State and Federal laws and regulations, including the WSP and National Park Acts. The results of current monitoring demonstrate that the management of the Mittelplate deposit is very safe. The facility has been working without incidents since the start of production. In consideration of the aims of Natura 2000 and the National Park Act, the required environmental impact assessments are carried out in an exemplary manner.

Coastal flood defense and protection

Coastal flood defence and protection, including the drainage of the hinterland, is an inherent feature of the Wadden Sea coast. Basically the whole of the boundary coastline of the nominated property is delineated by seawalls or dune systems to protect the people living in the area and their economic assets. The current level of protection will not be compromised under any foreseeable circumstances. The current line and system of coastal flood defence and protection will be maintained and no further embankment will be undertaken or is planned in any parts of the nominated property in the foreseeable future. The aim is to keep the local impacts within a temporary timescale. The current and future flood defence standards demand, however, continuous reinforcement and adaptations of future coastal protection measures to rising sea level. This cannot be done without impacting the nominated property. Reinforcement of the existing dikes will be carried out on the dikes. The use of sand for sea defence purposes will be combined as far as possible with the maintenance dredging of the shipping lanes. Coastal protection on the islands within the nominated property will be done by sand nourishment from the offshore area, which is the most environmentally friendly and most efficient solution for stabilizing eroding coasts. Comprehensive research projects are being conducted in different regions to investigate the relationship between grazing and the accumulation of flotsam and jetsam. These projects are investigating the consequences of a reduction in grazing intensity on coastal protection and aim at achieving an appropriate level of grazing intensity.

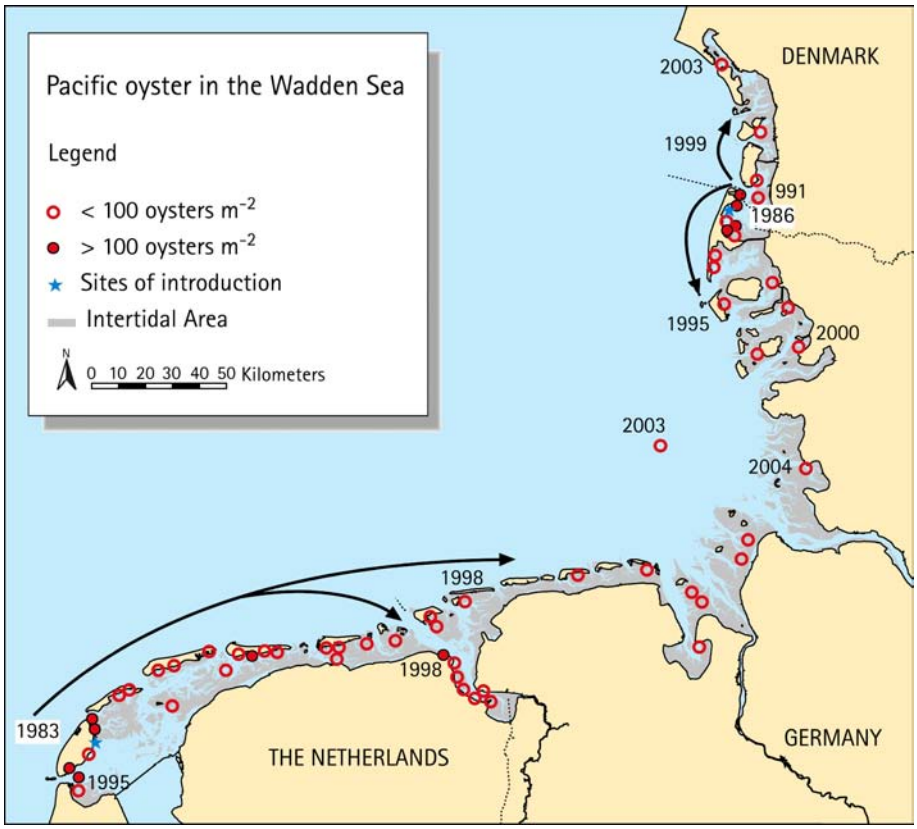


Figure 4.9: The Pacific oyster (*Crassostrea gigas*) in the Wadden Sea. Asterisks indicate sites and years (boxed) of introduction (Texel, Sylt). Other years indicate first records of settlement by larval dispersal for selected sites. Circles show mean abundance in 2003 (from QSR 2004).

Basically, as a management principle, since the natural dynamics in the tidal area are directly related to coastal flood defence and protection activities on the mainland coast, the islands and the offshore zone, coastal flood defence and protection policies will, as a principle, be based on these interrelationships.

Since the 1999 QSR, considerable progress has been made at the trilateral level on harmonizing the interests of nature protection and coastal defence as it has been agreed in the Wadden Sea Plan. One example is the establishment of the expert group on Coastal Protection and Sea Level Rise (CPSL) in 1999. For the first time, experts from national coastal defence and environmental administrations are discussing, on a trilateral level, strategies to maintain safety standards in coastal defence in a sustainable way that should be beneficial or, at least, not negative, for natural assets such as natural dynamics and habitat quality. In addition, an integration of nature protection and coastal defence has been achieved during the last years. Examples are the positive experiences from the first five years of an integrated salt marsh management in Schleswig-Holstein, the commonly agreed salt marsh plan set up for part of the coastline in Niedersachsen in 2003 and the re-embankment of summer polders in the area 'Noord Friesland buitendijks' and on the island of Langeoog in the Niedersachsen part of the nominated property.

Introduced species

At the North Sea coast, introduced algae and invertebrates arrived via shipping or via aquaculture. They most often became established within estuaries and on hard substrates, with more than 80 known species, of which about 52 also occur within the Wadden Sea.

Of the some 52 known introduced species, six have already had or are about to have effects on the composition of the existing biota in the Wadden Sea: cord-grass (*Spartina anglica),* Japanese seaweed *(Sargassum muticum*), bristle worm (*Marenzelleria cf. wireni*), American razor clam *(Ensis americanus),* American slipper limpet *(Crepidula fornicata),* and Pacific oyster (*Crassostrea gigas).* These species differ in their effects, some of which may be of a dynamic character (*i.e.*, sediment retention by *Spartina*, habitat provision by *Sargassum*, more food for birds by *Ensis*, displaced seagrass by *Spartina*, out-competing mussels by *Crassostrea*). Global warming may benefit *Spartina, Crepidula* and *Crassostrea* in the coming years,

resulting in further changes in dominance. Some introductions have become extremely numerous locally, such as the bristle worm *Marenzelleria*. It is as yet unknown what the community effects will be. There is, however, no evidence that introduced species have caused the extinction of natives in the Wadden Sea (Wolff, 2000).

The development with regard to introduced and immigrated species are followed and monitored carefully. No species can be intentionally introduced into the nominated property, e.g. for aquaculture, without an assessment according to the Habitats Directive.

Other activities

Though the construction of new wind turbines is not allowed within the nominated property, it can be expected that cables from planned and anticipated wind farms in the North Sea will have to cross the nominated property in the majority of the cases. This will, however, mainly cause only a temporary impact on the Wadden Sea. The construction of such cables is also subject to assessment and permission under the Habitats Directive.

It is unavoidable that further cables and pipelines will be constructed through the nominated property and, subsequently, also maintained, including such for the supplying of the islands. The construction of such infrastructure installations is likewise subject to assessment and permission under the Habitats Directive. It is the aim to keep the intervention into the nominated property of a temporary character.

Fishery may affect the natural environment of the nominated property. In the 1980s and 1990s, the quality of the different flats in the Dutch Wadden Sea decreased greatly, mainly because of the impact of mussel and cockle fishery, which had an impact on the biological quality, but also on the sediment dynamics and sediment composition. However, rehabilitation measures that have been taken since then have seemed to work out well. As outlined in Chapter 2, the most important fisheries within the nominated property nowadays are for blue mussel and shrimp. Shrimp fishery is mainly done in the area off the islands. These fisheries are subject to a comprehensive coordinated management scheme which aims to ensure that the nominated property will not be negatively affected.

Disturbance may ensue from civil air traffic over the nominated property, in particular overland flights to and from the islands, but also helicopter flights from airports on the mainland to offshore installations. The activity in terms of landings and take offs has decreased significantly in recent years in most parts. Moreover, minimum flight altitudes and corridors have been introduced to minimize disturbance. Also, ultra light aircraft and advertisement flights are prohibited or regulated. The German Wadden Sea National Parks are marked as sensitive areas in aerial flight maps, and it is recommended to steer clear of them. The minimum flight altitude in the Dutch part of the nominated property is 450 m and 300 m in specifically designated corridors if weather conditions make it necessary. It is strongly recommended to use higher flight altitudes

Hunting is prohibited within the nominated property, with the exception of a few areas on the islands of Niedersachsen, confined to 10 days annually. Further exemptions for hunting for wildlife management and pest control are possible in the whole area.

The extent of military activities has been significantly reduced the last years. There are a few exercise areas within the nominated property such as the shooting range "Vliehors" on the island of Vlieland or the tidal area in front of the Meldorfer Bucht in Dithmarschen, Germany. All activities are limited in time to take account of the breeding and moulting times for birds and seals.

In addition to the already described uses, the following activities in the range of marine (bio-) technologies and marine research exist or are planned in the near future:

- The construction and operation of an application-oriented research facility for marine aquaculture in Büsum/Schleswig-Holstein outside the nominated property that is linked to the North Sea via a sea water pipe;
- The operation of an Ocean-Monitoring-System, covering nearly the whole Wadden Sea. The system delivers data for scientific projects and coastal protection measures and serves as a research platform for the participating companies;
- Algal farming outside the nominated property for production and further scientific development of methods for production of algae, especially for food consumption.

These projects will expand in the near future. It will be safeguarded that the expansion will not cause any adverse effects on the nominated property.

(ii) Environmental pressures (e.g., pollution, climate change, desertification)

Pollution

Rivers are by far the largest carrier of polluting substances from the land to the Wadden Sea. The German rivers Elbe, Weser and Ems, together with the Dutch IJsselmeer, discharge on average 60 km³ of water into the Wadden Sea each year. The rivers transport heavy metals, PCBs, pesticides like Lindane and large amounts of nutrients. The amount of polluting substances is to an important degree determined by the amount of water that is discharged by the rivers. This discharge shows large yearly fluctuations as a result of differences in rain and snowfall in the catchment areas. Major reductions in input of metals into the Wadden Sea mainly occurred in the late 1980s until the early 1990s, continuing moderately until 2002. In the Wadden Sea itself a general reduction in the concentration of pollutants can be observed.

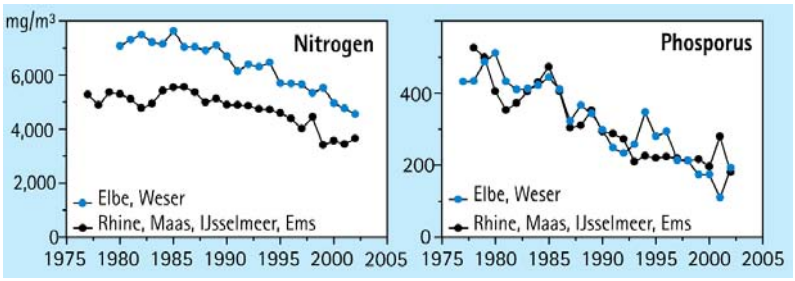


Figure 4.10: Riverine input of nitrogen and phosphorus (normalized on the annual freshwater discharge), (QSR 2004).

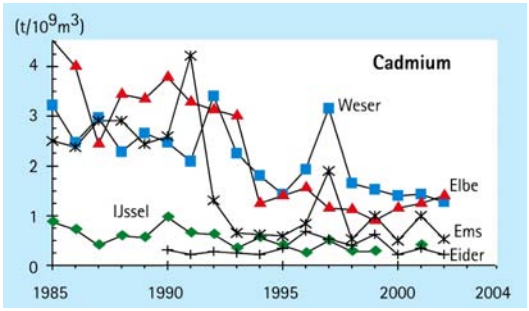


Figure 4.11: Riverine input of cadmium (QSR 2004).

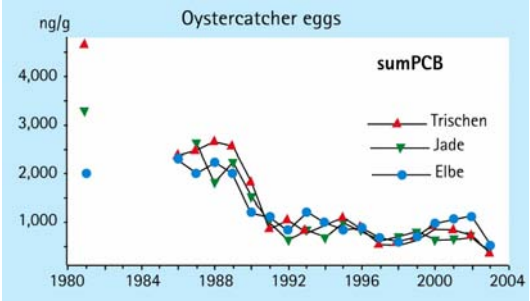


Figure 4.12: PCB concentration in Oystercatcher eggs, 1981–2003 (QSR 2004).

Nutrients

The two most important nutrients are nitrate and phosphate. Of these, the concentrations of phosphate started to decrease in the water of the Wadden Sea in the second half of the 1980s, mainly as a result of the use of phosphate-free detergent and water purification.

Though inputs of nutrients, especially of phosphate, have decreased, the present level of nutrients in the Wadden Sea is still about five times higher than before industrialization. The entire Wadden Sea still has to be considered a eutrophication problem area, meaning that the Target of a Wadden Sea which can be regarded as "eutrophication non-problem area" has not yet been met. Regional differences observed indicate a more intense eutrophication in the southern than in the northern Wadden Sea.

Hazardous substances

For some metals like mercury, lead, zinc etc., the Target of background concentrations in sediment and biota (blue mussels and bird eggs) has not yet been reached in all sub areas of the Wadden Sea. In most parts of the Wadden Sea region, concentrations of many contaminants are falling in the sediment and in living creatures. For a number of xenobiotic compounds, discharges to and concentrations in the Wadden Sea have decreased. Some of these substances still pose a risk to the ecosystem. Many newly developed xenobiotics, including hormone disruptors, have a wide occurrence in the Wadden Sea ecosystem, and these may have deleterious effects on the ecosystem.

Oil pollution

The nominated property is located adjacent to one of the world´s busiest shipping routes off the coast of the southern North Sea. Furthermore, – from a climatic point of view – this region lies within the west wind zone, which is characterized by changeable weather with adverse weather situations, like heavy winds and restricted visibility. Despite all national and international activities and despite the progress made in the improvement of ships' safety, shipping safety and the protection against maritime pollution, shipping will continue to be a potential source of risk for substantial damage to the Wadden Sea and the adjacent coastline. In the case of an accident with an oil tanker the damage would affect the area severely.

The most frequent source of oil pollution at sea is not tanker incidents but illegal discharges of fuel oil residues due to operational processes on board, which has caused a constant threat to

seabirds in spite of the designation of the North Sea as a Special Area according to Annex I and II of Marpol and the air surveillance of the whole area, which was introduced in 1986. A large proportion of seabirds washed onto beaches are contaminated with oil. Reported oil spills off the German and Dutch coast declined in comparison to the 1990s. Since the mid 1980s, the incidents identified per air hour declined from 1.5 to 0.2. Oil rates among beached birds of specific species of up to 90% in the 1980s have generally decreased, but are still high.

Climate change

Climate change and, in particular, its possible effects, have become a central issue in politics and science since the 1990s. To the layman the notion of climate change has almost become identical with anthropogenically-induced increases in the atmospheric concentrations of the so-called greenhouse gases, most notably carbon dioxide. As a result, increasing temperatures and, consequently, increasing water levels are predicted, caused by the thermal expansion of the ocean water and the melting of glaciers and polar ice caps. Also, changes in wind climate are expected or have, according to some publications, already occurred. Although climate has always changed, the new feature of the present situation is the expected speed of the change. This acceleration may induce significant changes in the Wadden Sea system.

Changes in any part of the system will cause sediment transport to or from other parts of the system, leading to a new dynamic equilibrium. Therefore, a moderate sea level rise in the Wadden Sea, resulting from both natural and man-induced processes, will be compensated by the import of sediment, which, in the long term, derives from the tidal channels, shore-face and the beaches and dunes of the barrier islands. In addition to these hydrodynamical and morphological processes, the importance of biotic processes for sedimentation and erosion has to be underlined. In this respect, the relevance of seagrass and mussel beds for biodeposition and reduction of erosion and the role of vegetation in the formation of dunes is emphasized.

It can be concluded that, generally, changes caused by sea level rise will not easily be distinguishable from changes resulting from the high natural variability, which is a specific feature of the Wadden Sea system. Moreover, there will be large differences in changes occurring in the different tidal basins. Because the Wadden Sea has a high resilience to changes, it is plausible that the system will be able to adapt to a sea level rise of up to some 25 cm per 50 years (the most realistic scenario) without substantial changes.

Beyond such levels, probably a breakpoint will occur, because the capacity of the system to balance the changes will become exhausted. When such a breakpoint, which will differ for different tidal basins, has been passed, substantial changes in morphological and, consequently, biological parameters are expected. One of the major changes will be a reduction of the size of the intertidal area. It is estimated that, under the worst-case scenario (50 cm per 50 years), the size of the tidal flats could decrease by 15%, the tidal basins becoming more the character of tidal lagoons. An increase in storminess would further enhance this development.

The reduction of tidal flats will have important consequences for biological parameters, most notably bird species depending on the intertidal areas for foraging. A reduction in the populations of such species can be expected, not only because the potential feeding area will be less than today but also, and probably more important, because the feeding time will be less. For the worst-case scenario, changes in other morphological and biological parameters may also be expected. They concern, amongst others, an increase of erosion on the barrier islands, a significant erosion of the salt marsh cliffs, a decrease in benthic biomass, a decrease in seagrass and an increase in typical salt marsh vegetation.

The main socioeconomic consequence envisaged is an increase in costs for coastal defence. Under the most realistic scenario (25 cm per 50 years) an increase of costs for dike maintenance and strengthening of at least 5 to 15% is expected. Under the worst-case scenario, costs to maintain dike safety may increase by 75% in Germany and even more in the Netherlands. Also, the costs for other coastal defence measures, such as sand nourishment and salt marsh works, will increase considerably. Another important consequence of increased sea level is that possibilities for discharging freshwater from the mainland into the sea will become less and that additional sluicing, pumping and/or freshwater storage capacity will be needed.

(iii) Natural disasters and risk preparedness (earthquakes, floods, fires, etc.)

It is not expected that the Wadden Sea is subject to natural disasters as meant by the guidelines in the sense that they constitute a threat to the whole area and its integrity. The nominated site is the result of a complex interaction of erosion and sedimentation at the shallow coastline of the North Sea. These still ongoing dynamics are the main feature of the site. The system has survived severe storm events in the past, which have altered the landscape and wiped out former settlement areas. Thousand of people and cattle drowned during these storm floods. These experiences have led to today's coastal defence and protection plans with the highest possible safety standards for the inhabitants inside and outside the Wadden Sea.

The nominated property is, however, subject to certain risks from shipping offshore its boundaries. As indicated above, access to the ports in connection with transit traffic to Scandinavia or to the Baltic Sea has turned the sea area off the Dutch and German coast into one of the regions with the highest traffic concentrations in the world.

The (marine part of the) nominated property has been designated a Particularly Sensitive Sea Area (PSSA). The PSSA designation is part of a comprehensive regime of protection measures for shipping safety and ships' safety set up by the International Maritime Organization (IMO), the European Union, or at the trilateral or the national level. This regime includes in particular Vessel Traffic Management System (VTMS), Traffic Separation Scheme (TSS), pilotage and mutual emergency management.

The TSS divides the sea traffic according to the main traffic directions into two one-way routes. Vessels carrying dangerous goods and deep draft vessels navigate the offshore routes far away from the coast and are thus separated from the other traffic according to the mandatory routing system adopted by the International Maritime Organization (IMO). With the exception of recreational traffic, which is usually limited to the summer months, the volume of shipping is spread evenly over all the months of the year. In view of the vessel traffic characteristics of the area, the Wadden Sea and adjacent North Sea still have an excellent record of only a few accidents and incidents. For example, during the period 1995-1999, a total of almost 800,000 ship movements in the German North Sea resulted in just over 100 incidents.

In the case of an emergency, a comprehensive set of contingency plans are in place to respond to oil pollution, for emergency towing of ships and mutual assistance in case of emergencies between the Wadden Sea countries in the framework of the DENGERNETH-Agreement concluded under the Bonn Agreement for cooperation in dealing with pollution of the North Sea by oil and other harmful substances. The best approach remains to prevent accidents from occurring and continued effort is therefore being made to maintain and, where necessary, increase shipping safety and the safety of the ships through an improved VTMS and international cooperation.

Risk-bearing companies and/or substances are allowed, provided that in case of calamities no irreparable damage to the nominated property is caused.

(iv) Visitor/tourism pressures

Tourism and recreational activity are a substantial part of the public experience of the Wadden Sea. They constitute a unique opportunity to experience the natural and scenic values of the area and one which also makes an important contribution to the regional and local economy, but also may potentially have a negative impact on the values of the Wadden Sea. The major part of the tourist activities, including the development of e.g. infrastructure, takes place outside the Wadden Sea, but all activities are so intimately linked to the nominated property that it is essential to take the broader scope when describing and assessing tourism and visitor activities.

In describing the activities, it is normally discriminated between land-based tourism and recreation, tidal flat walking, which is a particular activity of the nominated property hardly known anywhere else, and, finally, recreational boating.

Land-based tourism and recreation

Approximately 10 million tourists stay overnight and 30-40 million day trippers visit the Wadden Sea region every year (the region being the Wadden Sea, the Wadden Sea islands and the adjacent mainland areas).

For the German coast, more detailed data is available which also cover accommodations not listed in the official statistics (Tab. 4.4). Recent studies in Schleswig-Holstein have shown that the official tourism statistics underestimate by far the real numbers of guests, overnight stays and, subsequently, turnover. Boarding houses and pensions with less than 9 beds as well as visits to friends and relatives contribute a considerable share (53% of total), which is not included in the official data collections (Tab. 4.4).

Tidal flat walking (Photo: Martin Stock).

In the Niedersachsen Wadden Sea region, a turnover of 1.53 billion EUR for tourism (all kinds of accommodation) was calculated, based on 27.7 million overnight stays plus 2.6 million overnight stays on camping sites and 16.5 million day trips. Thus, as shown in Table 4.4, tourism figures are substantially higher than indicated in official statistics (accommodation facilities with more than 8 beds). Table 4.4 gives a sum of 43.5 million overnight stays for the Niedersachsen and Schleswig-Holstein Wadden Sea region per year.

The total number of overnight stays in the Dutch Wadden Sea region was 10 million in 2005 (data include facilities < 9 beds; data source: official national statistics: CBS 2005, Toerdata Noord, 2006).

Tourism has an extraordinarily high economic value for the region (estimated turnover of 2.8-5.3 billion EUR per year) and provides an increasing number of jobs (about 37,900 jobs in the entire Wadden Sea region in 2000). Due to globalization, intensified competition and modified consumer habits, tourism in the Wadden Sea is subject to changes, which opens up new opportunities at the same time. The growth markets of wellness/fitness, walking/hiking, and nature-oriented holidays and leisure activities fit well into the Wadden Sea region. Also, the aging population may have a positive consequence. Therefore, attractive outdoor and indoor offers are important for nature experience, emotional experiences and fun-oriented environmental education for all target groups, disabled and elderly people included.

Tidal flat walking

Tidal flat walking is the crossing of the tidal area during low water and offers a unique nature experience, which can be offered hardly at any other place on earth in this way. Walking on the "bottom of the sea" is the most exceptional way to undergo the "mystery" of the Wadden Sea and creates an intimate understanding of what this area is about and why it is so outstanding.

In the Netherlands, walking on tidal flats predominantly takes place on the 'Groninger wad' and the eastern part of the 'Frisian wad'.

	Destination North Sea Coast Niedersachsen		Destination North Sea Coast Schleswig-Holstein	
Type of accommodation:	**Overnight stays**	**Share of total %**	**Overnight stays**	**Share of total %**
Accommodation facilities >8 beds (recorded in official statistics)	11.9 million	43	7.5 million	47
Accommodation facilities <9 beds (boarding houses, pensions)	13.3 million	48	7.1 million	45
Visits to friends and relatives	2.5 million	9	1.2 million	8
Total	**27.7 million**	**100**	**15.8 million**	**100**

Table 4.4: Tourism in the Niedersachsen and Schleswig-Holstein Wadden Sea regions in different types of accommodation. (Data sources: Niedersachsen: Accommodation facilities >8 beds: Niedersächsisches Landesamt für Statistik, other accommodations: Regionale Innovationsstrategie Weser-Ems (RIS, 2004). Schleswig-Holstein: Accommodation facilities >8 beds: Statistisches Landesamt Schleswig-Holstein, other accommodations: SGVSH and TVSH (2003), year of data collection: 2002) (Table from QSR 2004).

Horse riding on the beaches (Photo: Martin Stock).

The numbers of participants per year have been in the range of 65,000 to nearly 80,000 persons in the period 1997-2002. In Niedersachsen, the total numbers of persons counted in the Wadden Sea from aircraft varied between 10,000 in the year 2000 and 18,000 in 2002 (sum of five flights during the summer holidays respectively). Groups of walkers (assumed to be participants in a guided tour) constitute a 15-29% share of the total number of persons recorded. In Schleswig-Holstein the number of guided tours in the Wadden Sea increased by 20% during the period 1999-2002. In 2002 nearly 5,000 guided tours with 116,000 participants took place.

In the Netherlands, tidal flat walking is regulated in the 'Provincial Tidal Flat Walking Bye-law'. Often, it concerns a ramble or a crossing to one of the islands. Tidal flat walking is only allowed with a permit granted by the province. For reasons of safety of participants and of protection of natural and landscape values of the area, it was recognized that extension of the number of tours and the number of participants was not advisable. Therefore, seven tidal flat walking organizations and the provinces signed the 'Tidal Flat Walking Covenant'. This covenant includes agreements on the maximum number of tours and participants and on zoning of tours. In addition, a code of conduct for participants was set up. On a yearly basis the total number of walkers may not exceed 50,500. In the last years the numbers of walkers were well under this limit. The yearly average number of people that is involved in tidal flat walking activities is about 30,000 – 35,000. In addition to this, permits are given for guided tours for environmental education. In total, there are about 75,000 people that participate in one of these types of guided tours each year.

As in the Dutch part of the nominated property, there are strict regulations for tidal flat walking of groups in Niedersachsen also. Guidance of tours on the tidal flats of the mainland or the islands and for crossing to some of the islands (there are official routes only to 4 of the 7 East-Friesian islands) is only allowed with a permit, for which examinations in safety, first aid, tidal flat ecology and National Park matters have to be passed. Similar regulations apply to most of the Schleswig-Holstein part of the Wadden Sea. Guides who additionally take part in National Park educational courses receive certification as National Park Guides. In addition to the guided tours, tidal flat walking is a very popular recreational activity.

Recreational boating

In general, only in the Dutch Wadden Sea can a clear trend be seen with respect to the number of boats. Both the number of sluice passages and the number of berths have increased since 1982. The number of berths in the fourteen marinas surrounding in the Dutch Wadden Sea increased from 4100 in 2001 to 4377 in 2006.The yearly number of sluice passages in the Dutch Wadden Sea has increased from 105,000 in 1997 to 122,000 in 2005. In Schleswig-Holstein, the boat traffic has

not significantly increased or decreased during the last 20 years. The highest density of leisure boats and excursion boats/ferries was observed around the North-Frisian islands.

Regulation

The tourist and recreational activities in and adjacent to the nominated property are, as appropriate, comprehensively regulated. It is difficult if not impossible to determine the carrying capacity of an area like the nominated property, which is so vast and complex, but it is justified to state in general that recreational activities are so well regulated and managed that they do not cause any adverse impact on the property. It is perfectly capable of absorbing the current and, possibly, an increased activity level in the future. On the contrary, while the nominated property attracts many tourists because they want to enjoy also the unique nature, the silence and the scenic beauty, they contribute to a significant extent to the comprehension of the natural values of the area, and in a wider sense to the protection and conservation of the Wadden Sea and the well being of those who live in the region.

Within the nominated property, a zoning system is applied which regulates access and recreational boating in time and space. The most sensitive areas, such as the breeding and resting areas for birds and seals, are closed the whole or part of the year. Also, regulations and a code of conduct apply for falling dry with recreational boats. Voluntary agreements exist between yachting associations and the nature protection authorities to provide additional protection and prevent disturbance in those areas where access is not prohibited. Tidal flat walking is basically only allowed with a permit and on designated routes. Speed limits have been imposed for recreational boating for the largest part of the nominated property. The use of jet skis, water skis and similar equipment is basically prohibited or confined to smaller designated areas within the nominated property.

For activities in the areas adjacent to the nominated site, a comprehensive planning system exists which aims to direct and regulate tourism. The building of tourist infrastructure, including e.g. marinas, is subject to assessment and planning and will only be allowed if there is no adverse impact on the nominated property. The planning system, including the spatial planning, also limits the use of space and natural resources. All things considered, the tourist and recreational activities are well controlled and the current planning, legal and management system is robust enough to sustain an increase in the activity and prevent an adverse impact to result from it on the nominated site.

(v) Number of inhabitants within the property

The number of inhabitants within the nominated property is 3 (2007).

5. PROTECTION AND MANAGEMENT OF THE PROPERTY

5.a Ownership

Most of the nominated property is state (federal or state) owned and only a very small part is privately owned.

In the Dutch part of the nominated property around 6% is owned by three private associations and one regional authority:

- The "Groninger Landschap" (the Groningen Landscape Society) is a private provincial nature conservation and management society. Its objective is to conserve nature and cultural history in the province of Groningen. The "Groninger Landschap" owns the "Punt van Reide" (46 ha), salt marshes in the "Dollard" (4204 ha) and the salt marshes "Noordkust" (200 ha);
- The "Noord-Hollands Landschap" (The Noord-Holland Landscape Society) owns some smaller areas, the "Balgzand" and "Amstelmeer", in total 120 ha;
- "Natuurmonumenten" (Nature Monument Society) is a private nature conservation society; it owns almost 10,700 ha of the nominated property. The areas owned by "Natuurmonumenten" are "Uithuizerwad" (63 ha), mud flats in the "Dollard" (3846 ha), "Griend" (100 ha) and "De Schorren" (6681 ha);
- "Wetterskip Fryslân" (Friesland Water Authority), is a government agency in the province. The authority is responsible for water management in the province. It owns 670 ha of salt marshes at the north coast of the province of Fryslân.
- The private nature conservation societies "Groninger Landschap", "Noord-Hollands Landschap" and "Natuurmonumenten" serve a public goal. They protect and manage the areas of the nominated property, basically on behalf of the national government, including the public awareness of these sites. Smaller parts, primarily mainland salt marshes, are owned by private owners such as farmers. They are organized in the Landowner Association.

Area	ha	km²	Ownership
Key Planning Decision Area (PKB) Wadden Sea	256,263	2,562.6	State owned 241,000 ha (94 %) "Groninger Landschap" 4,450 ha "Noord-Hollands Landschap" 120 ha "Natuurmonumenten" 10,690 ha "Wetterskip Fryslan" 670 ha
Wadden Sea National Park Niedersachsen	277,685	2,776.9	92.5 % federally owned 6 % state owned 1 % owned by municipalities 0,5 % private property
Wadden Sea National Park Schleswig-Holstein	439,614	4,396.1	98.3 % federally owned 1.6 % state owned 0.1 % private property
TOTAL WADDEN SEA PROPERTY	**973,562**	**9,735.6**	

Table 5.1: Overview of land ownership in the nominated property.

Hallig Südfall
(Photo: Martin Stock).

5.b Protective designation

As stated in Chapter 3 of the nomination, the Wadden Sea is subject to comprehensive protection, management and monitoring, both in the national as well as in the international context unprecedented in terms of its integrated and harmonized approach. The recognition that the Wadden Sea required a common protection and management approach in order to ensure that it would be protected and managed in respect of its shared character is more than a generation old.

The first formal International Wadden Sea Scientific Conference was held in 1975. In 2009 the 11th Scientific Conference will be held. At the Symposia, scientists from the three Wadden Sea countries exchange relevant research findings and formulate recommendations to the political level. The Symposia also deal with management issues. The findings of the scientific symposia have been and are important for the development of trilateral and national policies in terms of protection, management, monitoring and research.

The first Governmental Conference on the Protection of the Wadden Sea was held in 1978 in The Hague, the Netherlands. In 1982, at the 3rd Conference in Copenhagen, the "Joint Declaration on the Protection of the Wadden Sea" was signed. Within the Wadden Sea Cooperation, conferences are held every 3-4 years. The 10th Wadden Sea Conference was held in 2005 at the island of Schiermonnikoog.

Parallel to and within this framework, the national protection of the Wadden Sea developed in such a way that over the past generation the entire nominated property has been subject to the highest and most comprehensive legal protection under national legislation. It is very important to acknowledge the choice that was made a generation ago, i.e. to basically adopt "avant la lettre" an ecosystem and sustainable use approach to the long-term protection and management of the Wadden Sea, within which human activities will continue.

In addition, the nominated property is subject to protection under relevant European Union legislation and designations as well as under international agreements and conventions which contribute to enhancing and safeguarding its outstanding international importance.

Trilateral Wadden Sea cooperation

1. The Joint Declaration on the Protection of the Wadden Sea, 1982

The Joint Declaration on the Protection of the Wadden Sea **(Annex 10)** was signed at the 3rd Trilateral Governmental Conference on the Protection of the Wadden Sea in Copenhagen in 1982. In this declaration, the governments recognize their responsibilities for the conservation of the ecosystem and declare their intention to coordinate their activities and measures to implement a number of international legal instruments in

the field of natural environmental protection, amongst others the Ramsar Convention and the EC Bird Directive, for a comprehensive protection of the Wadden Sea region as a whole, including its flora and fauna.

Since 1982, seven Governmental Wadden Sea Conferences have been held and the trilateral cooperation has been strengthened and intensified.

2. Administrative Agreement on a Common Secretariat for the Cooperation on the Protection of the Wadden Sea, 1987

The Common Wadden Sea Secretariat was established in 1987 following a decision at the 4th Wadden Sea Conference in The Hague in 1985. The basis for the secretariat is the Administrative Agreement (**Annex 11**) concluded in 1987 between the competent ministries of the three countries. The Administrative Agreement stipulates the tasks and the financing of the secretariat and its staff. The secretariat has been located in Wilhelmshaven since its establishment in 1987.

3. Agreement on the Conservation of Seals in the Wadden Sea, 1990

The Seal Agreement (**Annex 13**) was enacted on October 1, 1991 as the first agreement, as defined in Article 4, of the Convention on the Conservation of Migratory Species of Wild Animals (CMS, Bonn Convention). The Seal Agreement was concluded between the Wadden Sea countries with the aim of cooperating closely in achieving and maintaining a favourable conservation status for the common seal population of the Wadden Sea.

4. Declarations of the Trilateral Conferences on the Protection of the Wadden Sea, 1978 – 2005

The declarations issued on the occasions of the Wadden Sea Conferences are political declarations, in which agreements are made between the governments, which are relevant for all areas of the cooperation such as management, monitoring, international cooperation, etc. The declarations are therefore an integrated part of the total protection and management of the nominated property to which the governments have committed themselves. The Guiding Principle of the Trilateral Wadden Sea policy, as agreed upon at the 6th Conference in Esbjerg, 1991, is "to achieve, as far as possible, a natural and sustainable ecosystem in which natural processes proceed in an undisturbed way". The Wadden Sea Plan, the policy and management plan for the nominated property, which includes the central objectives and principles of the Wadden Sea Cooperation, is also an agreement made at the 8th Conference in Stade, 1997. The Trilateral Monitoring and Assessment Program (TMAP), associated with the implementation of the Wadden Sea Plan, was launched on the same occasion.

5. Wadden Sea Forum

At the 2001 Wadden Sea Conference the Wadden Sea Forum (WSF) was established. The WSF is a stakeholder forum of representatives of regional and local governments and main sectors in the Wadden Sea region. The task of the WSF was to develop a sustainable development strategy for the Wadden Sea Region respecting the current level of protection of the Wadden Sea. The WSF sustainable development strategy "Breaking the Ice" was submitted to the 2005 Wadden Sea Conference at which the Governments indicated that they subscribed to the strategy as a start of the process to implement this strategy through the WSF action plan.

National protection of the Wadden Sea

The Netherlands

The protection of the Dutch part of the nominated property combines a unique national physical planning approach (the Key Planning Decision Wadden Sea (PKB)) with a designation of the nominated property under the Nature Conservation Act, 1998 supported by additional designations.

1. Key Planning Decision Wadden Sea, 2007 (3rd Policy Document Wadden Sea)

Since 1980 the Netherlands Wadden Sea has been protected according to the PKB Third Policy Document of the Wadden Sea (**Annex 16**), which is a national physical planning decree defining the overall objectives of conservation, management and use of the Wadden Sea. The PKB is a specific integrated physical planning instrument of the Spatial Planning Act and its objectives and conditions are binding for all state, regional and local authorities. The PKB document is valid for the whole Dutch part of the nominated property. The PKB is subject to amendment on a regular basis. The latest amendment was issued in 2007 after adoption by Parliament.

2. Nature Conservation Area

Through the Nature Conservation Act (1998) (**Annex 15**) nature areas designated as Special Areas of Conservation (SACs) according to the Habitat Directive, and as Special Protection Areas (SPAs) under the Birds Directive are protected under the aforementioned Act as nature reserves. The conservation objectives for these Natura 2000 areas

Engelsmanplaat (Photo: Jan Huneman).

are stipulated in a ministerial order together with the delimitation of the area. Management plans outlining the required measures will be drawn up for each area. Arrangements will be made with provincial authorities to implement them. According to legislation it is prohibited without permission to undertake activities which destroy and damage the protected area including its flora and fauna or its scenic importance. The guiding principle is that human activities are allowed as long as they are consistent with the major goal of the policy given in the PKB document. Therefore, the actual legislation includes an assessment frame to be used when the acceptability of proposed new activities has to be determined.

3. Act on the Wadden Sea Council, 2002

The act establishes the Wadden Sea Council. The Council is to be considered a continuation of the Advisory Board established in 1982. The Wadden Sea Council is an independent advisory board and advises the governments and the parliament on issues of general importance for the Wadden Sea region such as policies (regional, national, trilateral) with regard to, for example, fishery, recreation, the development of management plans and the improvement of the governing structure for the area and with regard to the development of a sustainable development perspective. Its members are designated on the basis of their technical knowledge and do not represent specific sector interests.

4. Ecological Main Structure

The Dutch part of the nominated property is also designated part of the Ecological Main Structure (EMS), which is the coherent national ecological network of nature areas. The aim of the EMS is to prevent plants and animals from extinction in isolated areas and the devaluation of nature areas. For each of the areas of the EMS a specific 'nature goal' is defined. This is a testable objective for a nature area. At the national borders the EMS connects with other areas of the Pan European Ecological Network (PEEN).

5. National Parks

Parts of the islands of Schiermonnikoog and Texel, also within the nominated property, are designated national parks in accordance with national legislation.

6. Environmental Protection Area

Areas that have a special conservation status based on the Nature Conservation Act 1998 or the Ramsar Convention, and are thus part of the nominated property, are designated as Environmental Protection Areas in accordance with the Environmental Management Act. This means that the Environmental Decree issued by the provincial government includes at least regulations concerning the protection of the quality of groundwater and the prevention and restriction of nuisance by noise.

Germany

In Germany the coastal federal states are responsible for the implementation of the Federal Nature Conservation act. The Federal Nature Conservation Act is a federal framework act for nature conservation which includes provisions for the establishment of nature reserves and

Kachelotplate
(Photo: Klaus Meinen).

national parks. According to §24 of the Federal Nature Conservation Act (2002), national parks are larger areas of national importance of which the major part is undisturbed and qualify to be designated as a nature conservation area. The aim is to safeguard, in the greater part of the area concerned, undisturbed ecosystem interactions and their natural dynamic processes to the extent possible.

Schleswig-Holstein and Niedersachsen established national parks for the nominated property in 1985 and 1986. The objectives of the national parks are to protect the Wadden Sea and to allow natural process to take place with a minimum degree of disturbance and other detrimental effects of human activities. The national parks have been divided into two or three zones of which the zone I includes the ecologically most valuable areas. Therefore, strict regulations apply to the zone I, including extensive restrictions to public admittance. In zone II, utilization and activities are allowed under such conditions that the overall protection objectives are not impaired. Each national park is managed by an administrative authority, the national park authority, which is responsible for the implementation of the provisions of the national park instruments.

1. Act on the Protection of the Schleswig-Holstein Wadden Sea, 1985 (amended 1999)

The Schleswig-Holstein Wadden Sea National Park was established in 1985 by state law, which was amended in October 1999 (**Annex 18**). In comparison with the 1985 law, the amended law entails in particular a seaward extension of the National Park, including the designation of a small cetacean conservation area off the islands of Sylt and Amrum, a new definition of the protection objective and the introduction of a new zoning system, including a zero use area. Two statutory boards of trustees represent the local authorities and the most important stakeholder interests on county level. They advise the national park authority on basic issues and long-term planning.

2. The Order on the Protection of Excavation, 1973

The order, issued in 1973, aims to protect the archaeological values of the marine area of the Schleswig-Holstein part of the nominated property north of the Eiderstedt Peninsula.

3. The Act on the National Park Niedersachsen Wadden Sea, 2001

The Niedersachsen Wadden Sea National Park was designated in 1986 by state statutory order, which was given the status of state act in 1999 (**Annex 17**). The act was amended in 2001 to include a major extension of the area seaward and in the Ems estuary, and a rezoning of the park. The inhabited islands, except for the villages, are part of the National Park.

4. Order on the Navigation on the Federal Waterways in the National Parks in the area of the North Sea, 1997

The marine area of the German part of the nominated property is federal waterways. Navigation is hence to be regulated by Order of the Federal Minister for Traffic. An order was issued in 1992 and amended in 1995 and 1997. The order estab-

lishes speed limits for navigation in the National Parks and closed areas comprising of seal haul out sites, and breeding and moulting areas for birds.

International protection of the Wadden Sea

The Wadden Sea countries are contractual parties to a number of international agreements, conventions and treaties, in particular, the Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar Convention); the Convention on Biological Diversity (CBD), the Convention on the Conservation of Migratory Species of Wild Animals (CMS, Bonn Convention) also covering the Agreement on the Conservation of Seals in the Wadden Sea (Seal Agreement), the Agreement on the Conservation of African- Eurasian Waterbirds (AEWA) and the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS), the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) and the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention). The nominated property has also been designated as Man and Biosphere (MAB) Reserves under the United Nations Educational, Scientific and Cultural Organization (UNESCO).

Some of the most relevant international conventions and agreements for protecting the Wadden Sea will be mentioned here, being aware that there are more treaties and conventions valid for the property.

Due to the strong interactions between the Wadden Sea and the adjacent North Sea, the trilateral policy and management regarding pollution is closely related to the OSPAR Convention and the North Sea Conferences.

1. Ramsar Sites

The *Ramsar Convention* 1971 is a world wide treaty for the conservation of wetlands: shallow open waters and any land regularly or intermittently covered or saturated by water. In the framework of the Convention, wetlands of international importance are designated by the contracting parties. Nearly all parts of the Wadden Sea have

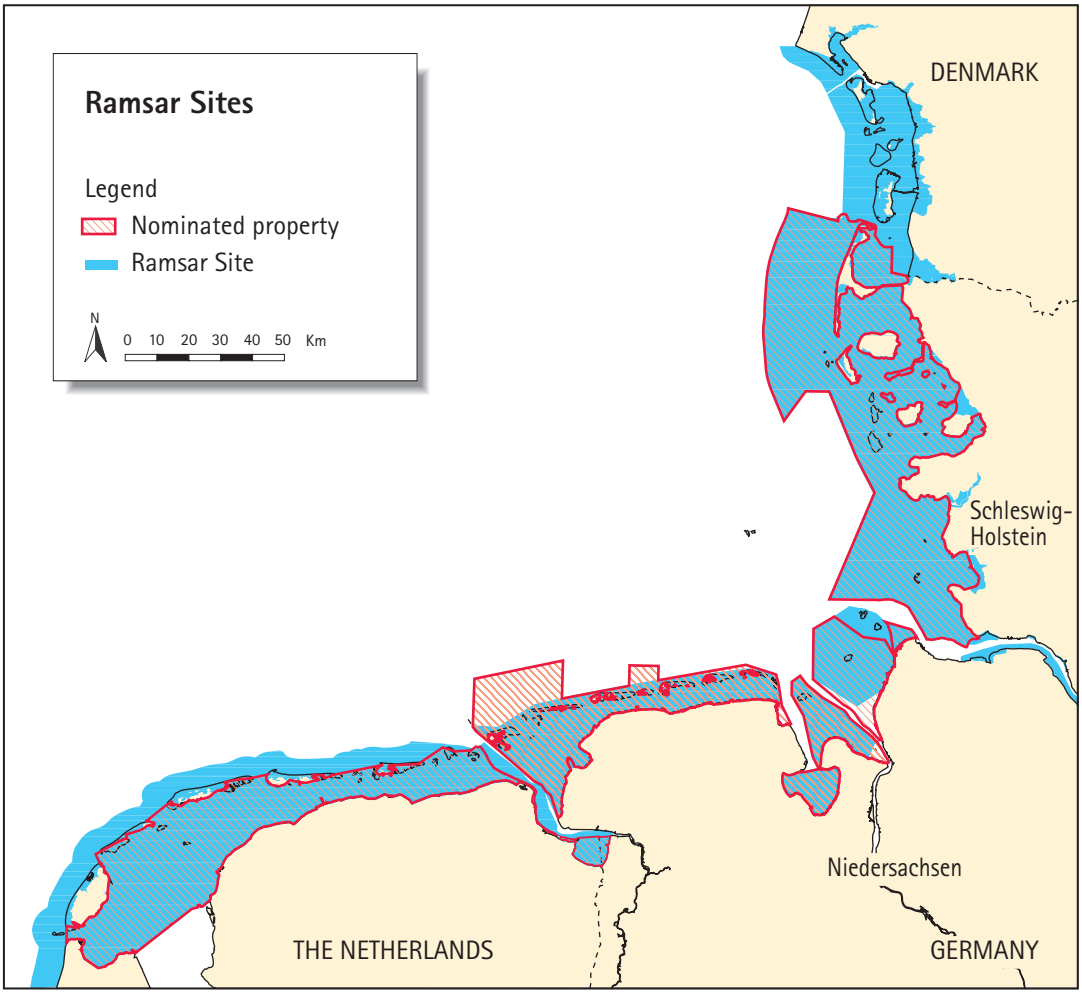


Figure 5.1: Map of Ramsar sites within and adjacent to the nominated property.

been designated as *Ramsar sites*.

2. Particularly Sensitive Sea Area Wadden Sea

In 2002, the Wadden Sea was designated as a Particularly Sensitive Sea Area (PSSA) (**Annex 14**) by the International Maritime Organization (IMO). The area designated as a PSSA is the marine area of the Wadden Sea. The PSSA covers an area of approximately 13,000 km²; the major shipping routes have been excluded from the designation. The PSSA does not limit shipping in the area nor the use of the Wadden Sea harbours. The designation of the PSSA Wadden Sea is seen as a recognition of the extensive regime of the national and international protective measures already in place in the Wadden Sea and adjacent the North Sea. Examples are the MARPOL Special Areas prohibiting discharges of oil and garbage, routing systems making certain routes compulsory for ships carrying hazardous goods and compulsory reporting for ships. An evaluation of the PSSA is agreed before the 2010 Wadden Sea Conference.

3. Man and Biosphere Reserves

The nominated property has been designated Man and Biosphere (MAB) Reserve under the UNESCO Man and Biosphere Program by the Netherlands and the two German states. Whereas the MAB-Reserve in the Dutch and Niedersachsen part is nearly identical with the nominated property, the MAB Reserve in Schleswig-Holstein also includes 5 Halligen as development zone adjacent to the nominated property.

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

The Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) was concluded in 1991 under the auspices of the Convention on Migratory Species (UNEP/CMS or Bonn Convention) and entered into force in 1994. The nominated property is within the agreement area. The aim of the agreement is to promote close cooperation amongst parties with a view to achieving and maintaining a favourable conservation status for small cetaceans. A Conservation and

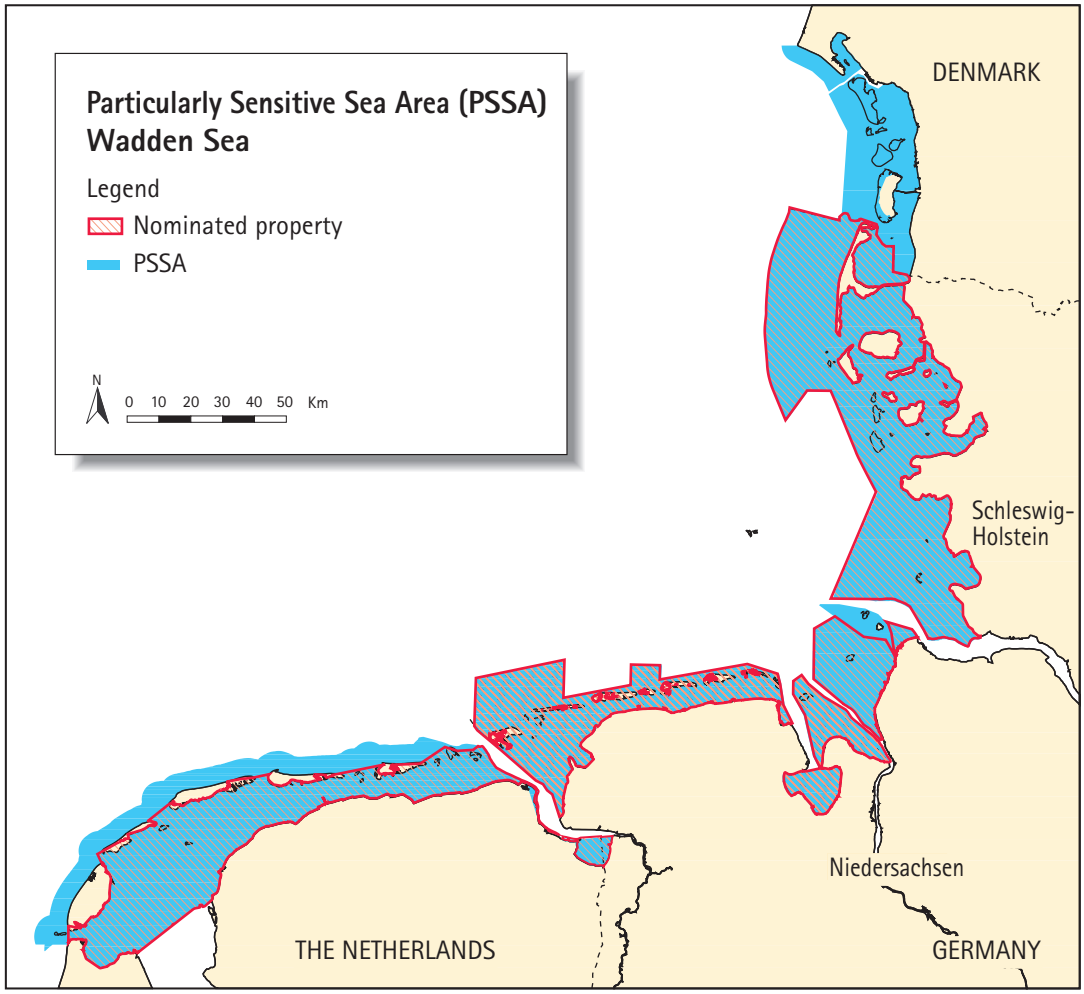


Figure 5.2:
Map of the Particularly Sensitive Sea Area (PSSA) Wadden Sea.

Management Plan forming part of the agreement obliges parties to engage in habitat conservation and management, surveys and research, pollution mitigation and public information.

5. The African-Eurasian Waterbird Agreement, 1995

The African-Eurasian Waterbird Agreement (AEWA) concluded under the Bonn Convention focuses on migratory waterbirds. It was concluded 1995 in The Hague, the Netherlands, and entered into force in 1999. The secretariat is located in Bonn, Germany. AEWA's flyway approach to waterbird conservation is unique. Being a regional agreement, AEWA focuses on 235 waterbird species ecologically dependent on wetlands for at least part of their annual cycle, including many species of pelicans, storks, flamingos, ducks, waders, terns, gulls and geese. The AEWA Agreement area covers 117 Range States in Africa, Europe, as well as parts of Canada, Central Asia and the Middle East. The geographic area stretches from the northern reaches of Canada and the Russian Federation to the southernmost tip of Africa. The AEWA is of particular importance for the Wadden Sea, being the key stepping stone for migratory birds within the agreement area.

European Union

The European Union legislation in the field of environment is of specific significance for the Wadden Sea and has increased in importance during the past two decades. The European Union legislation is trans-boundary and, increasingly, covers all environmental policy areas. The legislation also has direct implications for Member States' legislation. Of the comprehensive list of environmental legislation, the Habitats, Birds and the Water Framework Directives are the most relevant pieces of legislation for the protection and sustainable use of the nominated property.

1. Birds and Habitats Directives

The Council Directive 79/409/EEC on the conservation of wild birds (Birds Directive) was adopted in 1979 and aims at the protection of all species of naturally occurring birds in the territory of the member states. According to the Birds Directive,

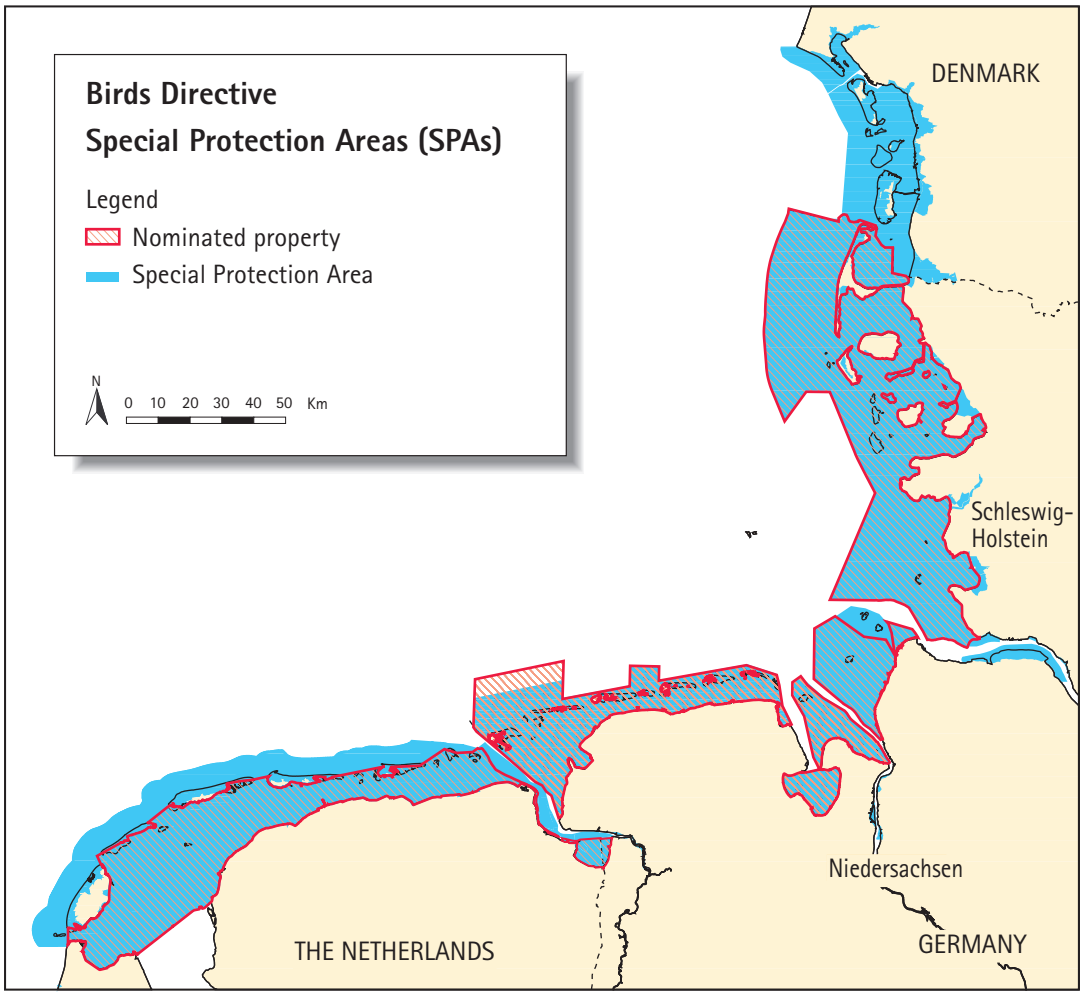


Figure 5.3: Map of the Special Protection Areas (SPAs) within and adjacent to the nominated property.

member states must classify the most suitable territories for the conservation of the species listed in Annex 1 of the directive, as 'Special Protection Areas' (SPAs). The greater part of the nominated property has been designated as SPA.

The Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (Habitats Directive), adopted in 1992, complements the 1979 Birds Directive. It has the aim of ensuring that biodiversity is maintained through conservation of important, rare or threatened habitats and the habitats of certain species. In the framework of the Habitats Directive a coherent ecological network, called NATURA 2000, is being established. NATURA 2000 will consist of Special Areas of Conservation (SACs) designated according to the Habitats Directive, and the SPAs of the Birds Directive. The nominated property has been or will be designated as SAC.

The Wadden Sea is part of NATURA 2000 and subject to the provisions of the Habitats Directive, of which Article 6 is a crucial one. Article 6 stipulates that for special areas of conservation, member states shall establish the necessary conservation measures involving, if need be, appropriate management plans specifically designed for the sites or integrated into other development plans. Member states shall also take appropriate steps to avoid, in the special areas of conservation, the deterioration of natural habitats and the habitats of species as well as disturbance of the species for which the areas have been designated, in so far as such disturbance could be significant in relation to the objectives of this directive. A report on the ecological status of NATURA 2000 areas has to be delivered to the European Commission every six years.

A plan or a project likely to have a significant effect on the areas shall be subject to an appropriate assessment of its implications for the site. Only if it will not adversely affect the designated conservation area shall a competent authority agree to the plan or project. If a project or plan must nevertheless be carried out for imperative reasons of overriding public interest in the absence of alternatives it must be compensated to ensure

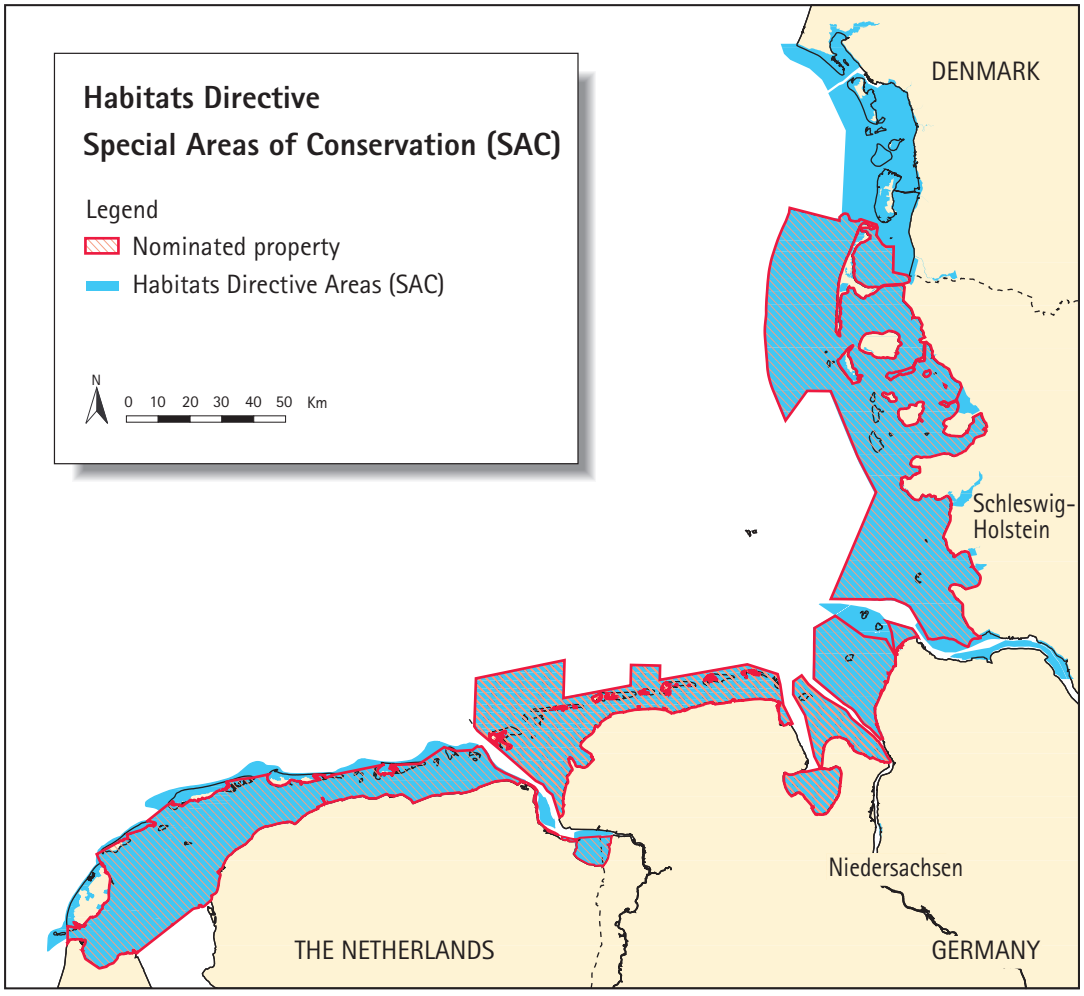


Figure 5.4:
Map of the Special Areas of Conservation (SAC) within and adjacent to the nominated property.

the overall coherence of the NATURA 2000 network. These provisions are legally enforceable by the European Court of Justice.

2. Water Framework Directive

The Council Directive 2000/60/EC on establishing a framework for Community action in the field of water policy (Water Framework Directive, WFD) was enacted in 2000. It aims at a coordination of all water-related measures on the European level. The key elements of the WFD include the protection of all waters, surface and ground waters in a holistic way and the achievement of good quality ('good ecological status') by 2015. A first analysis of pressure and impacts was reported by the member states in 2005.

A River Basin Management Plan has to be prepared by 2009, based on the results of an operational monitoring program (to be established by 2006). River management plans are to be reviewed every 6 years.

The Wadden Sea has been assigned to six different River Basin Districts (RBDs), differentiated in coastal and transitional waters. These RBDs are the main management units of the WFD and cover all types of surface and ground waters. Coastal waters cover the areas up to 1 sm from the baseline and, with regard to the chemical status, also the territorial waters (up to 12 sm) (Figure 5.5).

Regarding the Habitats, Birds and Water Framework Directives, the Schiermonnikoog Conference reaffirmed that a coordinated and consistent implementation will continue to be a central aim. The Wadden Sea Plan will be further developed into a management plan in accordance with the stipulations of the mentioned directives.

3. Other European Union legislation

Other relevant European Union legislation includes the Environmental Impact Assessment Directive and the Strategic Environmental Assessment Directive, which are of central importance for the assessment of the environmental impacts of policies, plans and concrete projects. Also, the recommendation of the European Parliament and the Council on Integrated Coastal Zone Management is of particular importance for the Wadden Sea,

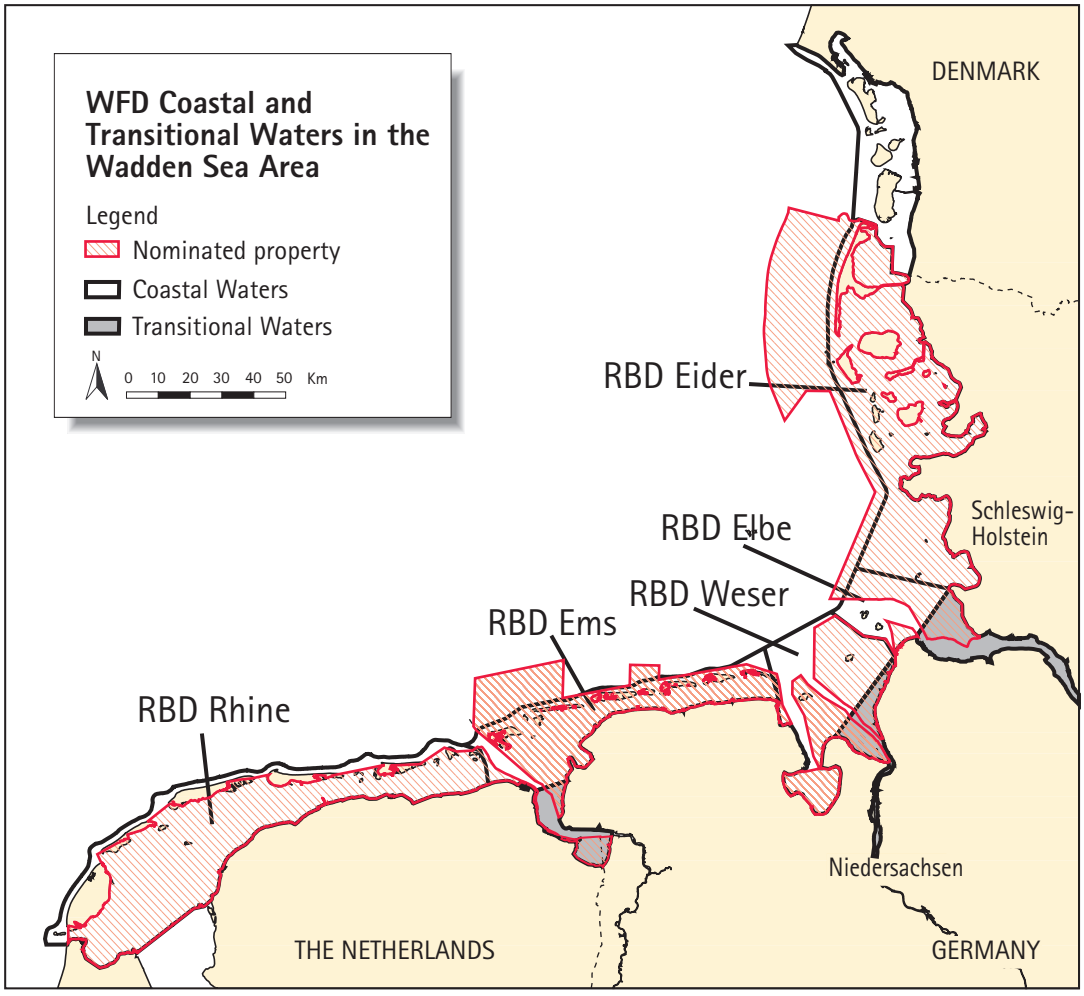
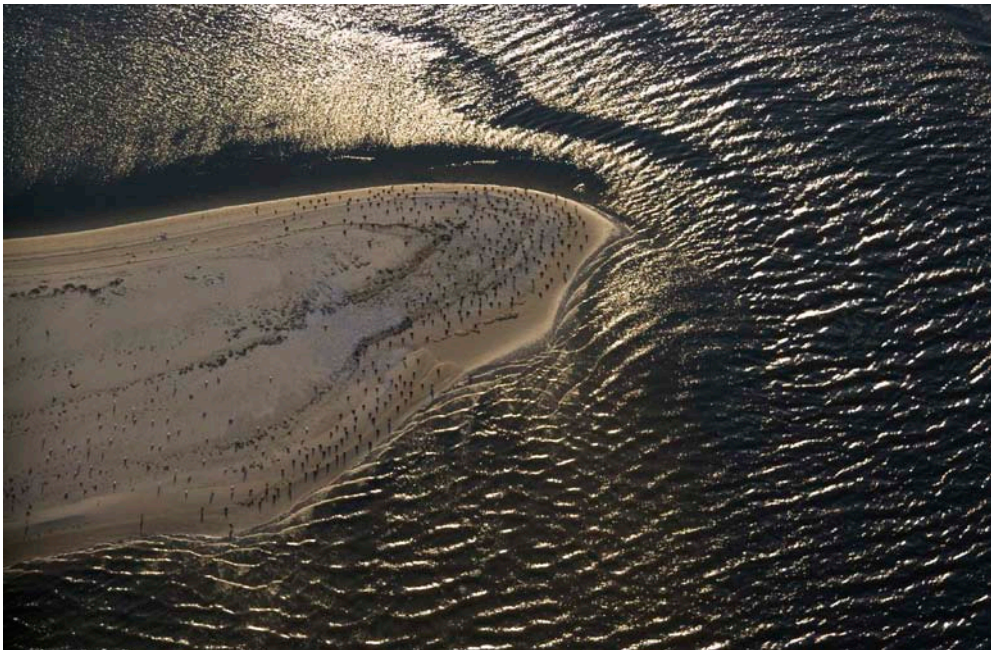


Figure 5.5: Map of the Water Framework Directive Coastal and Transitional Waters within and adjacent to the nominated property.



Sandbank in the Wadden Sea (Photo: Martin Stock).

it being a site located at the interface between land and sea and to be managed according to this specific characteristic.

5.c Means of implementing protective measures

An essential feature of the protection afforded to the nominated property is that the framework of the trilateral Wadden Sea Cooperation provides it with one comprehensive protection and management scheme, with additional layers of protection ensuing from international legal instruments within the same comprehensive scheme.

The trilateral Wadden Sea Cooperation forms the overall common framework for the protection of the nominated property within the Joint Declaration signed by the parties. At consecutive ministerial conferences and within the Wadden Sea Plan, common principles, objectives and policies have been agreed upon. The Guiding Principle, as agreed at the 1991 Wadden Sea Conference, is "to achieve, as far as possible, a natural and sustainable ecosystem in which natural processes proceed in an undisturbed way". This overall guiding principle is supported by several management principles such as the "Principle of Careful Decision Making" and the "Precautionary Principle". Further, a comprehensive set of primarily ecological Targets were agreed upon by the cooperation at the 1994 Wadden Sea Conference in conjunction with the common delimitation of the Wadden Sea Cooperation Area as a basis for the common management of the Wadden Sea. As mentioned above, this has been followed by many other additional agreements of significance for the protection of the Wadden Sea.

Though these agreements are of a political nature and have no direct legal implications, they are commitments that are made on the highest level between governments in the understanding that the governments will apply, enforce or implement them using their national and international instruments and their full scale of other regulatory and management possibilities.

Though there are differences how the relevant national legal protection instruments are composed within the overall framework, which naturally follows from the apparent differences in legal schemes, they are basically similar in objectives, protection regulations and enforcement.

German Wadden Sea

The protection objectives of the German Wadden Sea National Parks covering the German part of the nominated property are to protect the Wadden Sea and its natural development. The natural processes should be allowed to proceed as undisturbed as possible. It is explicitly stated, however, that coastal defence measures and measures undertaken in conjunction herewith are not to be restricted. Furthermore, the Schleswig-Holstein National Park Act explicitly stipulates that unreasonable impairment upon the interests and the customary practices of the local population shall be avoided. In addition, all issues of use and

exploitation have to be impartially considered in the light of the overall protection aims of the national parks and individual cases. The conservation of nature by the national park should lead to an improvement of the living and working conditions of the human population living within the region through positive repercussions on tourism and the reputation of the region. This is currently a common Wadden Sea wide understanding of the added function of the protection and management schemes for the nominated property also embraced by the Wadden Sea Plan.

The national parks are divided into two respectively three protection and management zones with different levels of regulations. In the highest protection zone, resource use and access is in principle prohibited. In the other zones access and use of resources is conditionally allowed.

The Schleswig-Holstein National Park is divided into two zones, in which different activities are allowed. The core zone, zone 1, comprises coherent tidal basins and covers about 36% of the National Park. Public access is prohibited, with the exception of e.g. tidal areas adjacent to the coastline, tidal flat walking routes, and commercial fishery as stipulated in Section 6 (2) of the act. Within the core zone, an area south of the Hindenburg causeway of 12,500 ha has been designated as a zone in which all resource use has been fully prohibited. It is only allowed to navigate in the zero use zone on the marked shipping lanes. The area covers about 3% of the National Park area. Any activity which could cause destruction, damage or change to the protected area or any part thereof or that could lead to lasting disturbance, is prohibited. Permitted activities are explicitly stated in Section 6 of the National Park Law. The kind and location of activities is primarily determined by the zoning concept. Additionally, hunting and cockle fishery, which prior to the new amendment were largely phased out, are now completely prohibited within the National Park. The same holds for wind turbines.

The Niedersachsen National Park, which includes the uninhabited part of the East Frisian Islands, is divided into three zones. Zone 1 – the core zone – covers 61 % of the total area and includes the ecologically most valuable areas. All activities which destroy, damage or change the National Park or its components are prohibited. Public admittance is prohibited with the exception of assigned paths and routes. Some human activities (farming, hunting on parts of the islands and fishing) are still possible, but only under restricted conditions. Zone 2 – the intermediate zone – covers 38.5 % of the total area. All activities which change the character of the Wadden Sea, including the islands, in particular the scenic value or nature impression, are prohibited. A list of specifically prohibited activities is annexed to the act. Admittance is allowed to this zone, with the exception of the salt marshes during the breeding season for birds, from 1 April until 31 July. Zone 3 – the recreational zone – covers about 0.5 % of the total area. Only recreational activities and health resort activities are allowed there. Paragraph 17

Eroded sediment showing tubes of the sand mason (Photo: Imke Zwoch).

Harbour seals on a sandbank near Norderney (Photo: Imke Zwoch).

of the Niedersachsen National Park Act regulates possible exemptions and exclusions.

Resource use and activities that are not prohibited, coastal defence activities or those of a traditional nature according to the above mentioned national park acts are subject to licensing. Prior to issuing permits and exemptions the activity or project must be made subject to an assessment in accordance with the Habitats Directive.

Dutch Wadden Sea

As indicated in the previous chapter the protection of the Dutch part of the nominated property, though similar in structure to the German protection, combines a unique national physical planning approach with a designation of the property under the Nature Conservation Act 1998 supported by additional designations.

The PKB has the status of a law and its objectives and conditions are binding upon all state, regional and local authorities. The main objective of the PKB is a sustainable protection and development of the Wadden Sea as a nature area and conservation of the open landscape. This explicitly includes the conservation of landscape qualities, in particular the quietness, the openness and the naturalness. This objective, as indicated in the PKB, closely relates to the Targets, as entailed in the Wadden Sea Plan. The PKB must hence be implemented in regional and local spatial plans, taking into account that the nominated property is municipalized amongst the adjacent three provinces and municipalities. The municipalisation was done in the 1980s to ensure that the PKB would be implemented within the framework of spatial planning and hence guarantee that the objectives and policies of the PKB would be also binding upon the lower government levels. The local plans are binding legal documents with direct implications for the individual citizen or company. This approach was also opted for to engage and commit the regional and local authorities.

The designation of the nominated property as a nature conservation area is to ensure that the Nature Conservation Act 1998 and its stipulations can be applied. The PKB, in combination with the Nature Conservation Act 1998, guarantees special protection for the Dutch part. According to this legislation it is prohibited without permission to undertake activities which destroy and damage the protected area including its flora and fauna or its scenic importance. The guiding principle is that human activities are allowed as long as they are consistent with the major goal of the policy given in the PKB document. Therefore, the actual legislation includes an assessment frame to be used when the acceptability of proposed new activities has to be determined.

The PKB, in combination with the Nature Conservation Act 1998 (article 20) or the Criminal Code (article 461), allows for closing of zones in the area for public admittance for the whole or part of the year. The delimitation of these zones can be updated each year. It concerns mainly zones that are important for seals and breeding birds. About a quarter of the tidal flats has been

Salt marsh in the eastern part of Spiekeroog (Photo: Martin Stock).

closed for cockle and mussel fishery. Based on the trilateral agreement laid down in the PKB document and the Policy Decision on Shellfish Fisheries (2004) in the eastern part of the Dutch nominated property, a reference area is designated. This area is about 7,400 ha, which is about 3% of Dutch part of the the property, and it includes all the important ecological features. It has been closed for shellfish fisheries since 1993. In the reference area, exploitation of biotic and abiotic resources and other disturbing activities is not allowed. The area serves comparative monitoring and research in the Wadden Sea.

Stakeholder involvement

Advisory Boards have been established in the Dutch, Niedersachsen and Schleswig-Holstein part of the nominated property. Though there are differences in the remits and composition of the boards they are very important in terms of consultation and advice on Wadden Sea matters and the involvement of local and regional stakeholders in matters of protection and management of the nominated property. The Dutch Wadden Sea Council is composed of persons with an expertise on specific issues and not a representation of local and sectoral interests. Its task is to provide advice to authorities on matters of general importance for Wadden Sea protection and management but it can also on its own initiative investigate issues and provide advice.

The two Schleswig-Holstein Boards of Trustees are composed of representatives of the regional and local governments and regional stakeholders representing commercial, recreational and environmental interests. The Boards in addition provide advice to the National park Authority and must be consulted and give their consent on principal matters and on long-term planning.

The Advisory Board of the Niedersachsen National Park is also composed of representatives of the regional and local governments, regional stakeholders representing commercial, recreational and environmental interests and of scientific institutions. In regular meetings, the board is informed on all major activities in the National Park and gives advice to the National Park Authority.

European Union legislation

As outlined in the previous chapter the relevant European Union legislation becomes increasingly important also for the protection and management of the Wadden Sea. The Habitats Directive in conjunction with the Birds Directive are of particular significance for the nominated property. The objective of the NATURA 2000 network is to contribute towards ensuring bio-diversity through the conservation of natural habitats and of wild fauna and flora in the European territory of the member states. Measures taken pursuant to the Habitats Directive shall be designed to maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of Community interest.

The nominated property has been or will be

designated as SACs. In the case of the Wadden Sea this is already the case. Furthermore, conservation status objectives shall be elaborated as a basis for the legal protection and management of the site. This will be done within a trilateral framework. In the Netherlands this process has already been concluded (2007) in the sense that all NATURA 2000 areas will be officially designated, including the associated conservation targets. Management plans outlining the required measures will be drawn up for each area. Arrangements will be made with provincial authorities to implement them. For the German part of the nominated property conservation objectives have been or will be designated. These objectives are essential in the sense that they will indicate what should be done to maintain or restore habitats to a favourable conservation status.

Further, as outlined in the previous chapter, Article 6 of the Habitats Directive introduces the assessment of projects and plans as an integrated part of the licensing of such projects and plans and, in a broader sense all activities in the nominated property. If the assessment provides evidence that the plan or project will have an adverse effect on the property it may not be permitted unless for overriding public interest and in the absence of alternatives. Such must be compensated.

It is important to acknowledge that the authority that issues a permit is the competent authority and this is in many cases not the authority competent for nature protection. The competent authority will have to fully take account of the protection framework.

Enforcement

The protection measures outlined above and overall legal, planning and management framework is directly enforceable. Much attention is given to the enforceability of the regulations through the establishment of management and enforcement units, coordination with all other government authorities operating in the nominated property and the introduction of state of the art techniques for surveillance of regulations and also by aerial surveillance.

In Germany, most of the enforcement measures lie within the responsibility of the federal states. The most important responsibility in the Wadden Sea directly assigned to the federal level is the competence for regulating and enforcing all measures connected to shipping because the marine area of the property is a federal waterway. Shipping regulations are therefore kept under the surveillance of the Federal Ministry of Traffic through its federal shipping agencies. At state level, generally regulations are legally implemented through the regular terrestrial and water based police forces of the State Ministries of the Interior. The State Ministries responsible for e.g. nature conservation, coastal defence and protection, water management, fisheries and economic affairs act directly or through their respective regional authorities. There is a close cooperation on all levels, e.g. national park and fishing regulations being kept under surveillance of the water based police. For implementing regulations of the national park acts, the National Park Authorities in Schleswig-Holstein and Niedersachsen have

Ice winter in the Wadden Sea (Photo: Martin Stock).

Tidal flats at Cupidopolder–Boschplaat (Photo: Jan Huneman).

direct responsibilities. They are – differing from state to state – supported by wardens, volunteers and NGO´s. The counties and municipalities also have their own share of responsibility for the enforcement of actual legislation being in force in the Wadden Sea.

In the Schleswig-Holstein part, 16 "Rangers" from the National Park Service support the National Park Authority in the wardening of the area, together with non-governmental organizations which have been given contractual tasks in this regard in the area. In the Niedersachsen area, wardens employed at the coastal protection authorities and volunteers give advice to visitors and take care of the area. Also, the Water Police plays a significant role in terms of enforcement in the German part of the nominated property.

In the Dutch part of the nominated property, the national government as well as the provinces and the municipalities have their own responsibilities for the enforcement of the actual national legislation that is in force in the Wadden Sea. The enforcement of regulations that are valid for mainly shipping, fishing and recreational activities is carried out by the Ministry for Agriculture, Food Quality and Nature, the Ministry for Transportation Public Works and Water Management, the Water Police, the Military Police and customs services. In addition some supervisors/investigators of the provinces and some land administrators and regional Police Corpses are involved incidentally. These organizations co-operate in the Wadden Sea Enforcement Consultation Body. Their enforcement projects are included in a common long-term action programme. Co-operation is further facilitated by the Service Office Enforcement Wadden Sea.

It must, however, be acknowledged that enforcement is an issue for various reasons. Enforcement is difficult in an area of the size of the nominated property with its natural features, i.e. marine tidal area with limited accessibility. Furthermore, legal enforcement does not contribute to enhanced acceptance and therefore during recent years voluntary agreements have increasingly played a role.

In the Dutch part of the property for a trial period of four years it is allowed to beach a vessel beyond 200 metres from the buoyage of the navigation route, except for the closed zones, provided that a code of conduct is complied with. To this end, the joint authorities and the water sports organizations in the Dutch Wadden Sea area have signed the policy document 'Responsible beaching in the Wadden Sea'. The recreation organisations urge their members to adhere to the code of conduct "Wad, I love you" and that they take measures within their organizations in case the code is violated. The code of conduct not only applies to yachters but to everyone on the Wadden Sea. Also tidal flat walkers must follow the rules laid down in the code of conduct. The code of conduct is especially geared towards people's behaviour with respect to the species and habitats to be protected on which the Wadden Sea's designation as a Nature 2000 site is based. The

code of conduct is widely distributed and can be found in all marinas, in tourist information maps, in journals and magazines. Hydrographical maps of the Wadden Sea refer to the code of conduct. The trial is evaluated every year, and in 2007 a final evaluation will be made. Based on the positive results obtained so far it was decided to extend the trial for responsible beaching by a maximum of four years. The final decision on the formalization of this beaching policy will be based on an overall assessment that will be performed in the framework of the integral Wadden Sea Management and Development Plan (B&O –plan, see p. 129). The results of the final evaluation are important input for this overall assessment.

In the Schleswig-Holstein part of the nominated property there are many examples of such (voluntary) agreements between the National Park Authority and various stakeholders such as with the mussel and shrimp fishers or the water sport board. Ship companies operating in the area with excursion boats, tour guides, tourism enterprises and even local authorities have signed voluntary agreements as national park partners. Furthermore, contractual regulations with some municipalities are in force which govern in detail the use of individual coastal areas like St. Peter-Ording, Westerhever or Hamburger Hallig. Regular common evaluations have proven successful in creating win-win-situations for both partners. Also in Niedersachsen, voluntary agreements and certifications have become more and more important, especially with the arrangements initiated in the frame of the ongoing process of the implementation of a Biosphere Reserve development zone in the Wadden Sea region of Niedersachsen. All national parks in Germany work together on promoting the concept of voluntary agreements with potential national park partners.

5.d Existing plans related to municipality and region in which the proposed property is located (e.g., regional or local plan, conservation plan, tourism development plan)

It is important to acknowledge that the entire area of the nominated property is subject to a coherent protection and management system resulting from designations as a protected area and national parks and, hence, affording it the highest protection status nationally and internationally, including European legislation. As a rule, therefore, regional and local planning, including spatial planning, is to provide priority to the protection status of the nominated property in the sense of the criteria viii, ix and x. The planning system in place is therefore to be considered a supportive instrument to the current protection scheme.

An important development is currently unfolding. As a result of the European Parliament and Council recommendation on the development of Integrated Coastal Zone Management (ICZM) for the European Union coastal zone (2002/413/EG), the Netherlands and Germany have reported to the European Commission the status of ICZM for their coastal zones including the nominated property and how they intend to follow up with an ICZM strategy. This seems to be a very essential approach since the protection and management of marine areas is a challenge in the sense that many factors and developments are potentially very significant for the nominated property while, at the same time, such developments are subject to regulations under different national and international regimes. ICZM attempts to direct and manage such developments and, from the point of view of the nominated property, to ensure that it maintains its integrity and that developments take a sustainable approach. The nominated property is therefore potentially the area that will profit most from the further development of the ICZM strategy and, at the same time, the area that will be a most determining element within the ICZM strategy for this part of the coast and the adjacent marine area. The Trilateral Cooperation with e.g. the Wadden Sea Plan, supplemented by regional organisational structures like the Wadden Sea Forum or "Euregio the Wadden" are existing elements of an ICZM.

The large part of the ICZM strategy is already present in the current national planning that has also been developed or is relevant for the nominated property.

Germany

With regard to ICZM, in particular, the federal government, the Länder (German federal states) and local authorities have advanced activities parallel to the further development of the set of legal instruments in order to generate know-how and experience, foster sustainability in coastal zones, improve cooperation between governmental, economic, social and research institutions and organizations as well as to improve the quality of the available knowledge within the framework of research and project support.

With respect to the existing set of tools and activities, the national strategy envisages four

Glasswort
(Photo: Klaus Janke).

areas in which further steps should be pursued:

1. Further optimization of the set of legal instruments according to the basic ICZM principles;
2. Creation of the basis for continuation of the dialog process;
3. Best practice projects and their evaluation;
4. Development and application of ICZM indicators.

Planning, including spatial planning, is a competency of the state, regional and local levels of government. The state spatial planning of Niedersachsen and Schleswig-Holstein includes the territorial waters including the German part of the nominated property. In the spatial planning programs of both states, the nominated property is afforded the status of priority area for nature protection in the regional plans and, as such, also indicated on the state spatial planning maps. As a consequence, the spatial planning has to take full account of the status of the nominated property and its stipulations and nothing can be planned or undertaken which opposes this status.

The State Spatial Planning Program Niedersachsen ("Landesraumordnungsprogramm Niedersachsen") is currently (2007) being revised. In addition to maintaining and developing the status of the nominated property, it further stipulates that the nominated property is to be protected, supported and developed in its uniqueness through appropriate developments in the surrounding area. It is further stipulated that the MAB area in the adjacent area to the nominated property is to be further developed through model projects in the sense of sustainable development.

The Schleswig-Holstein State Spatial Plan ("Landesraumordnungsplan"), 1998 affords the above mentioned status of the nominated property. The 2005 Spatial Planning Report for Coasts and Sea aims to provide a comprehensive overview of all the uses of the coastal zone, with spatial implications and resulting actions. It fully embeds the nominated property within future spatial planning in accordance with its planning status.

The state planning system, as outlined above, has made a significant step towards implementing an ICZM approach within which the German part of the nominated property is firmly nested and is afforded an additional layer of protection.

The Netherlands

It is recalled that the protection of the Dutch part of the nominated property is afforded within a spatial planning framework through the national planning decree PKB. Furthermore, the nominated property is municipalized in regard of the adjacent provinces and the municipalities which are obliged to apply their spatial planning competencies also to the nominated property. This was, as stated earlier, deliberately done to guarantee that the spatial planning of the three levels of governments would be applied in a consistent way and would also take account of the land-sea interface. Regional and local (spatial) planning has therefore been an inherent feature in the Dutch approach from the outset.

It should be recalled that the PKB is an obligatory instrument for the regional and local government. Some of the decisions are directly binding upon these governments. Others are of a more indicative character. The provinces and municipalities have to take these into account

in their actual planning. A few are decisions of essential importance and can only be changed by a revision of the PKB.

The provinces Groningen, Fryslân and Noord-Holland cooperate in the Steering Committee Wadden Sea Provinces. The provinces have laid down a common integral policy in the Inter Provincial Policy Plan (IBW). This IBW includes the common view and goals concerning the future developments in the Wadden Sea. The major goal of the common policy is a sustainable conservation and development of the Wadden Sea as a nature reserve. Within this context, certain human activities are possible. There are two preconditions: safety of the inhabitants and accessibility of the islands and the harbours.

The IBW is used as a basis for:

- Gearing policies of provinces, municipalities and national government;
- Determining provincial views on policy and initiatives of the national government;
- Taking initiatives to get activities started that contribute to the realization of the common goals;
- Participation in management and implementation activities of others;
- Consultation with stakeholders such as public organizations and private companies in the region;
- Assessing plans of municipalities in the region concerned.

Based on the Calamities and Heavy Accidents Act and the Public Works and Water Management Act, the Regional Board for the Wadden Sea area (RCW) has stipulated the Co-ordination Plan Calamity Control Wadden Sea. The plan makes clear who is in charge at any given moment and for any given task and which administrative measures have to be taken in the nearby future to optimize the co-ordinated calamity control. Agreements on this as well as operational plans on calamity control are part of the plan. The plan has been signed by the involved municipalities, the provinces and the national government.

The Dutch islands in the Wadden Sea region cooperate in the council "De Waddeneilanden". Their common policy is laid down in the Policy Plan 2006 – 2010. The islands in Schleswig-Holstein cooperate within the "Island and Hallig Conference". Where international issues are concerned, a further cooperation between the Dutch, German and Danish islands is realized through a cooperation body entitled Euregio.

5.e Property management plan or other management system

Management

All partners concerned are aware of the outstanding universal value of the nominated property "The Wadden Sea" and their responsibility to preserve this site for present and future generations. This is reflected as well in the Trilateral Governmental Conferences and Declarations (www.wadden-sea-secretariat.org) as in regional declarations and decisions supporting the nomination (see **Annex 20**, Regional declarations supporting the nomination).

Based on this thoroughly shared understanding of the property the conservation of the outstanding universal value and the integrity of the nominated property "The Wadden Sea" is already and will be secured by an effective management system. It aims at safeguarding its geomorphological and biological processes, habitats and species and to maintain its biological diversity in line with the proposed criteria in chapter 3. This management system is a combination of the national management systems and the trilateral Wadden Sea Plan aiming at securing a coordinated management of the trans-boundary site located on the territory of two sovereign states, the Federal Republic of Germany and the Kingdom of the Netherlands and incorporating responsible authorities. An essential element of the management system of the nominated property is the Wadden Sea Plan (WSP), which is in **Annex 12**. The Wadden Sea Plan applies to both the nominated property "The Wadden Sea" and the adjacent areas covered by the Wadden Sea cooperation. Following this ecosystem approach the World Heritage Site will benefit from the fact that the management of the whole area coming under the trilateral Wadden Sea cooperation is based on the same comprehensive agreements set out in the Wadden Sea Plan.

The Trilateral Wadden Sea Plan was adopted at the 8th Wadden Sea Conference in Stade, Germany in 1997. The Wadden Sea Plan (WSP) constitutes the common trans-boundary policy and management plan for the Wadden Sea Area. It is important to acknowledge that the WSP is a policy and management plan adopted by governments for a trans-boundary area and therefore has a wider perspective than a traditional management plan for a site in the sense that the WSP encompasses also the vision, principles, policies and measures

and is a framework for the integrated protection and management of the Wadden Sea. The Plan is an agreement of how the countries envisage the coordination and integration of management of the Wadden Sea Area and of the projects and actions that must be carried out to achieve the commonly agreed targets.

The WSP is a coherent approach to the protection and management of the Wadden Sea in a trans-boundary context. In essence, it is an ecosystem approach and directed towards achieving and, hence, also maintaining the geomorphological and biological processes and the full scale of habitat types which belong to a natural and dynamic Wadden Sea in order to maintain biological diversity.

It includes the vision, shared principles, targets and policies and management measures combined with actions. The vision of the WSP is

- A healthy environment which maintains the diversity of habitats and species, its ecological integrity and resilience as a global responsibility;
- Sustainable use;
- Maintenance and enhancement of values of ecological, economic, historical-cultural, social and coastal protection character, providing aspirations and enjoyment for the inhabitants and users;
- Integrated management of human activities which takes into account the socio-economic and ecological relationship between the Wadden Sea Area and the adjacent areas;
- An informed, involved and committed community.

The shared principles include the already central Guiding Principle as referred to above "to achieve, as far as possible, a natural and sustainable ecosystem in which natural processes proceed in an undisturbed way". The associated management principles are fundamental for the common management of the Wadden Sea:

- The Principle of Careful Decision Making, i.e. to take decisions on the basis of the best available information;
- The Principle of Avoidance, i.e. activities which are potentially damaging to the Wadden Sea should be avoided;
- The Precautionary Principle, i.e. to take action to avoid activities which are assumed to have significant damaging impact on the environment, even where there is no sufficient scientific evidence to prove a causal link between activities and their impact;
- The Principle of Translocation, i.e. to translocate activities which are harmful to the Wadden Sea environment to areas where they will cause less environmental impact;
- The Principle of Compensation, i.e. that the harmful effect of activities which cannot be avoided, must be balanced by compensatory measures; in those parts of the Wadden Sea, where the Principle has not yet been implemented, compensatory measures will be aimed for;
- The Principle of Restoration, i.e. that, where possible, parts of the Wadden Sea should be restored if it can be demonstrated by reference studies that the actual situation is not optimal, and that the original state is likely to be re-established;
- The Principles of Best Available Techniques and Best Environmental Practice, as defined by the Paris Commission.

A very essential principle is that unreasonable impairments of the interests of the local population and its traditional uses in the Wadden Sea Area have to be avoided. Any user interests have to be weighed on a fair and equitable basis in the light of the purpose of protection in general, and the particular case concerned.

As emphasized above the trilateral conservation policy and management is directed towards achieving the full scale of habitat types which belong to a natural and dynamic Wadden Sea. Each of these habitats needs a certain level of quality, which can be reached by proper management of the area. This quality level can be described by certain characteristic structures, the presence of certain organisms, the absence of disturbance and toxic effects and by the chemical condition of the habitat.

For the common management six habitat types are distinguished:

- The offshore zone
- The beaches and dunes
- The tidal area
- The salt marshes
- The estuaries
- The rural area.

For the first five of these habitats ecological targets were adopted with the objective of maintaining and enhancing the area which is natural, dynamic and undisturbed, including targets for birds and marine mammals. These targets also equally ad-

TARGETS ON HABITATS AND SPECIES

SALT MARSHES

- an increased area of natural salt marsh;
- an increased natural morphology and dynamics, including natural drainage patterns, of artificial salt marshes, under the condition that the present surface area is not reduced; an improved natural vegetation structure, including the pioneer zone, of artificial salt marshes.

TIDAL AREAS

- a natural dynamic situation in the tidal area;
- an increased area of geomorphologically and biologically undisturbed tidal flats and subtidal areas;
- an increased area of, and a more natural distribution and development of natural mussel beds,*Sabellaria* reefs and *Zostera* fields;
- viable stocks and a natural reproduction capacity, including juvenile survival, of common seal and grey seal;
- favourable conditions for migrating and breeding birds:
  - a favourable food availability;
  - a natural breeding success;
  - sufficiently large undisturbed roosting and moulting areas;
  - natural flight distances.

BEACHES AND DUNES

- increased natural dynamics of beaches, primary dunes, beach planes and primary dune valleys in connection with the offshore zone;
- an increased presence of a complete natural vegetation succession;
- favourable conditions for migrating and breeding birds.

ESTUARIES

- protection of valuable of the estuaries;
- maintaining and, as far as possible, restoring the river banks in their natural state.

OFF-SHORE ZONE

- an increased natural morphology, including the outer deltas between the islands;
- a favourable food availability for birds;
- viable stocks and a natural reproduction capacity of the common seal, grey seal and harbour porpoise.

dress the preservation of the outstanding universal value of the nominated property according to the criteria for inscription (viii, ix, x).

In addition, for the rural areas on the islands and the mainland the supplementary targets are to improve the conditions for birds. Also supplementary targets on marine mammals, birds and mussel beds have been agreed upon, because these are important indicators of the biological quality of the ecosystem. Targets on the chemical quality of the Wadden Sea have been set as well. The essence of these targets: the concentrations of naturally occurring substances (for example nutrients and heavy metals) should be at natural levels and the discharges of non-natural substances, for example pesticides, should be zero.

The ecological targets are valid for the whole Wadden Sea Area. There are, however, differences as regards the extent to which the targets will be implemented, in the interest of balancing out nature conservation concerns and human use. The Wadden Sea Plan is valid for the whole Wadden Sea Area and covers also topics which are not all part of national conservation areas like estuaries, dunes and the offshore area. Common agreements for a comprehensive protection of the Wadden Sea have been endorsed for almost all human activities. The Wadden Sea Plan also stresses that sustainable human activities in the area remain possible in the future.

Projects and actions are part of the WSP. A number of projects and actions were agreed at the time of the adoption of the WSP in 1997 which are consistent with the target approach. The projects mainly relate to further investigations, whereas the actions are concrete actions for improved management. The large majority of these projects and actions have been implemented.

The state of conservation of the nominated property is regularly reviewed and reported within the Trilateral Monitoring and Assessment Program (TMAP) and additional monitoring carried out within the property. The TMAP is an integrated common monitoring program of the Wadden Sea states the Netherlands, Germany and Denmark (§ 33, Ministerial Declaration, 6th Trilateral Governmental Conference, 1991). The WSP is linked to the Trilateral Monitoring and Assessment Program (TMAP) outlined in chapter 6. The TMAP monitors the Wadden Sea in a manner consistent with the WSP approach and enables a permanent assessment of the status of the Wadden Sea and the implementation of the WSP. Periodic Quality Status Reports are published encompassing a comprehensive assessment of the status of the Wadden Sea ecosystem based on the information gathered in the framework of the TMAP. So far, four Quality Status Reports have been published, including the 1991 "Development Report".

Since 1997, the implementation of the WSP has been assessed in terms of policy and management at each of the subsequent conferences in conjunction with the Quality Status Reports and the assessment laid down in public policy assessment reports. The WSP is therefore subject to

Brown dunes on Spiekeroog (Photo: Imke Zwoch).

periodic assessment of its implementation not only in a technical framework but also at the highest political level, ensuring that the WSP is implemented at the government level (see Declaration of Schiermonnikoog 2005).

The WSP will be developed further and submitted to the 2010 Wadden Sea Conference in accordance with the stipulations of the EC Habitats, Birds and Water Framework Directives. The WSP will continue to constitute an essential element of the management system of the nominated property.

As a consequence of the "Agreement on the Conservation of Seals in the Wadden Sea" mentioned above, a Conservation and Management Plan has been adopted since 1991 and been revised periodically. The Seals Management Plan (SMP) outlines the management actions that are necessary to implement the stipulations of the Seals Agreement in conjunction with the Targets laid down in the WSP. The SMP also includes projects and actions to be implemented in the period jointly or by (one of) the contracting parties. The SMP is the only species-related common management plan within the Wadden Sea cooperation.

For stakeholder involvement advisory boards have been established. Though there are differences in the remits and composition of the boards they are very important in terms of consultation and advice on Wadden Sea matters and the involvement of local and regional stakeholders in matters of protection and management of the nominated property.

The Wadden Sea Forum is a stakeholder forum of representatives of regional and local governments and main sectors in the Wadden Sea region. The WSF has developed proposals for a sustainable development strategy for the Wadden Sea Region respecting the current level of protection of the Wadden Sea.

Implementation

The national management systems, the Wadden Sea Plan and the relevant EU legislations are important elements for the management of the Wadden Sea. The character and the application of the Wadden Sea Plan at the trilateral level and the implementation of the EU legislation has been explained above. The parties follow somewhat slightly different approaches in the sense that the formal implementation is different but not the substance and the achievements.

The involvement of stakeholders, allocation of resources and capacity, the cycle of implementation, monitoring, evaluation and feedback is secured. In addition, the enforcement programme assures the accurateness on a short-termbase. In case of accidents the available calamity control system (5d) will be activated. The effectiveness is maintained by regular training-sessions. All these systems are subject to regular assessments and adaptations.

In Germany most of the implementation and enforcement measures of the national management system lie within the responsibility of the federal states. Schleswig-Holstein and Niedersachsen established national parks in

1985 and 1986. The agreements of the WSP are implemented through the national park acts in conjunction with the directives and the management structure established with the national park acts. The national authorities oversee the implementation of the policy and management agreements. Each national park is managed by an administrative authority, the national park authority, which is responsible for the implementation of the management regulations.

Advisory boards of trustees represent the local authorities and the most important stakeholder interests in Schleswig-Holstein and Niedersachsen respectively. The stakeholder involvement aims at advising the national park authorities on basic issues and long-term planning.

The regional management in Germany supporting the national park acts combines sectoral strategies on different levels, ranging from legal enforcements on the level of decrees e.g. the Order on the Navigation on the Federal Waterways in the National Parks in the Area of the North Sea, and contractual regulations e.g. on municipality level to voluntary agreements between the national park authorities and various stakeholder groups. Regular common evaluations have proven successful in creating improvements for all partners involved. The regional management is regularly assessed on the basis of the results of the Trilateral Monitoring and Assessement Program, thus enabling a proper adjustment of the regional management. This is done in close consultation with the relevant stakeholders.

In the Dutch part of the nominated property an elaborate management system is in place in the framework of the PKB and the Nature Conservation Act (1998). This elaborated management system constitutes of a management plan, an implementation plan and an enforcement programme. This system is based on a common vision on the unique values and the corresponding conservation objectives.

The PKB includes a development perspective until 2030. Based on this development perspective, the Regional Wadden Sea Coordination Council (RCW) is setting up an integral Wadden Sea Management and Development Plan ("B&O-plan"). The integral character is the result of the common tuning of different management aspects between the different authorities concerned (legal instruments, maintenance and inspection, monitoring, information and education) and of the integration of all management information and maps. The intention is to integrate the management plans framed under the terms of the amended Nature Conservation Act (1998) and the Water Framework Directive into the B&O-plan as well. The Management Plan shows how the PKB, the Interprovincial Policy Plan Wadden Sea and different governmental notes concerning the Wadden Sea will be realized in concrete terms. The Management Plan is also an assessment frame to be used when a permit or an exemption is requested. The B&O-plan will be operational at the latest by the end of 2010. The B&O Plan will be revised at least once every six years in close consultation with the relevant stakeholders.

Based on the B&O-plan, a new Wadden Sea Implementation Program will be developed, describing measures and activities that are planned for the coming six years. In addition, periodically a Report Wadden Sea Implementation Programme will be issued describing the realization of the Wadden Sea Implementation Programme. Also, a new Wadden Sea Enforcement Programme will be developed, describing the modes of enforcement that are applied. These plans and programmes will be stipulated by the RCW. The RCW will take care that the different enforcement activities are co-ordinated efficiently.

For Schiermonnikoog National Park the Management Plan Schiermonnikoog National Park 1999-2008 is in force. This management plan describes the aims and starting points for the use and management of the National Park. It is the assessment frame for the project programme. Also for the national park "De Duinen" on Texel a management plan is in force.

5.f Sources and levels of finance

The funding available to the nominated property is complex when all funding is included for the ongoing protection and management of the area including enforcement, monitoring, awareness-raising and research, and activities related to trilateral and international work. The sources of funding are divided over many authorities and institutions, making it particularly difficult and challenging to make an exact estimate of the annual funding and the sources available for the nominated property in its entirety. The overview of the sources and level of funding has therefore been confined to the funding directly available for the protection and management of the property in terms of the protection objectives and the authorities and organizations directly responsible. Further sources of funding in addition to annual appropriations by governments and non-

Table 5.2: Sources and level of funding in 2007.

Governments	Source	Amount State
Germany: National Park Authorities and Services (Information Centres, Wardens) and NGOs	State	9,293,000 EUR
The Netherlands: National and regional authorities, service and coordinating agencies and NGOs	State	8,400,000 EUR
Common Wadden Sea Secretariat	State	640,000 EUR

government institutions have been listed to the extent possible. The overview in Table 5.2 gives an indication of the level of funding available. The appropriations are adopted annually by the national and state parliaments and may be subject to changes over time.

As outlined above wardening in the Schleswig-Holstein Wadden Sea is contractually delegated to NGOs. These NGO's run some information centres and warden specific areas of the National Park. They are supported by the state of Schleswig-Holstein.

Of the amount of almost 3 million EUR for the National Park Authority in Niedersachsen, 1,010,000 EUR are to be allocated for the maintenance of 14 visitor centres.

In 1994 the "Niedersächsische Wattenmeerstiftung" was founded by the state of Niedersachsen together with "Statoil" and "Ruhrgas", with a basic deposit of approx. 25 million EUR and a yearly distribution rate of approx. 1 million EUR. The fund supports scientific projects and activities with the aim to enhance the conservation status of the Wadden Sea or projects dealing with alternative energy.

In the Netherlands a Wadden Fund has been established. Through the Wadden Fund the Dutch government will make 800 million EUR available over the next 20 years.

The most important aims of the Wadden Sea Fund are to support activities that:

- Improve the values of nature and the landscape of the Wadden Sea area;
- Diminish or remove external threats to the natural wealth of the Wadden Sea;
- Contribute to a sustainable economic development in the Wadden Sea area or to a substantial transition to a sustainable energy household in the Wadden Sea area and the neighbouring areas (Groningen, Friesland and the northern part of Noord-Holland);
- Stimulate the development of an efficient and a sustainable knowledge management for the Wadden Sea area.

The capital comes from the benefits of natural gas production (750 million EUR) and from public funds (50 million EUR). Also the applicants themselves have to contribute to the funding of the project (co-financing). This increases the net investment. Thus the government expects to realise in the next 20 years a financial impulse of more than 1 billion Euros.

The government will set up an investment plan that describes the situation intended at the end of the funding period of twenty years based on the PKB. The government aims at funding projects that at the end of the funding period (20 years) will have contributed visibly to the improvement and conservation of the Wadden Sea area. During the first five years of this period, particularly projects will be funded that are urgent, that set a good example and that give results on a short term. The regional administrative bodies will have a prominent advising role in the assessment procedure for projects.

As indicated above, the funding available to the nominated property is much more if other funding is included in the overview. The funding of the research institutes with research tasks in the area, for example, has not been included in the overview. Because the nominated property constitutes a very important nature area, if not the most important one for research and monitoring in the countries, the funding is extensive. It concerns both annual funds as part of normal government appropriations as well as project funds. The latter constitute the larger part of the funds.

Financial support is also available from other funding agencies such as the European Union, which supports, for example, the LIFE-project, specifically designed for Natura 2000 areas and the LEADER+ programme for rural development. These funds are, however, appropriated to specific projects. Projects that have received funding from the LIFE programme are e.g. the visitor information system in the Schleswig-Holstein part of the nominated property, the trilateral seals project following the seals epidemic in 1988 or

the DEMOWAD-Project for data handling within the TMAP.

Also mostly not included in the overview are management costs to the area provided by other authorities than those responsible for nature protection.

5.g Sources of expertise and training in conservation and management techniques

The expertise and training available for the nominated property is very extensive. First of all, there is an extensive expertise available at the national park authorities and the conservation authorities. The staff involved in the conservation and management of the nominated property based at those authorities is academically trained and highly skilled. Also, those who are involved in daily management are based at authorities with decades of experience of working in the area. Furthermore, there is a long tradition of ecological research in the area from world wide recognized institutes and organizations. A generation ago, this resulted in the publication of the "Ecology of the Wadden Sea", referred to earlier, which collected all the information available from researchers and experts on all relevant themes and issues with regard to the Wadden Sea. This publication was a crucial element in the commencement of the ecosystem protection of the nominated property.

Since the publication of "The Ecology of the Wadden Sea" extensive research programs have continued and intensified. In the 1980s and 1990s, large ecosystem research programs were carried out both in the Dutch part as well as in the German part of the nominated property. The aim of the German project was to develop scientific foundations for protecting the Wadden Sea ecosystem, taking account of conflicts between uses and protection. Project efforts included analysing the region's natural dynamics, identifying and interpreting the processes that govern the spreading of plants and animals and developing mathematical models for describing the regional system.

Schleswig-Holstein

The national park office has cooperation agreements in place with all relevant research institutions around the area, such as the Wadden Sea station at the island of Sylt of the Alfred Wegener Institute in Bremerhaven, the Universities of Kiel (Büsum Research and Technology Centre (FTZ)) and Hamburg and the GKSS research centre in Geesthacht. Direct contacts are also in place with the West Coast University of Applied Science (Fachhochschule Westküste), the colleges of education of Kiel and Flensburg, the universities of Osnabrück and Bremen and the Royal Netherlands Institute for Sea Research (NIOZ) in the Netherlands.

Salt marsh gully on Wangerooge (Photo: Imke Zwoch).

The national park office regularly carries out training courses for "multipliers", in cooperation with various tourist facilities and service providers. Such events bring participants up to date with the latest developments and provide information about the aims of the national park and the biosphere reserve. The participants include staff of nature conservation associations, conscientious objectors in alternate civilian service, persons performing a "Voluntary Ecological Service Year", guides to tidal flats, staff of shipping companies and representatives of national-park communities and of the area's youth hostels. Special training courses are also offered for volunteer national park rangers and for full-time rangers of the National Park Service. A special focus of such efforts is on explaining the balance between protection and uses in the national park.

In addition there is a lot of experience available from NGOs, e.g. nature conservation organizations, some of them having been active in the area for decades, and from local inhabitants, some of them looking after the area voluntarily or being officially appointed as national park wardens.

Bird observation tower at the Engelsmanplaat (Photo: Jan Hunemann).

Niedersachsen

Since the 1930s, the Wadden Sea in Niedersachsen has been the subject of intensive ecological and hydrological research, carried out by various institutions, including the "coast" research center of the Niedersachsen state office for water, coastal protection and nature protection ("Niedersächsischer Landesbetrieb für Wasserwirtschaft, Küstenschutz und Naturschutz "), the "Senckenberg by the Sea" research station (Wilhelmshaven), the Ornithological Research Institute (Institut für Vogelforschung, Wilhelmshaven) and the University of Oldenburg. Research results have been published in numerous scientific publications. Studies have been carried out in all subsystems of the Wadden Sea ecosystem (open mud flats, salt marshes, beaches and dunes). The research emphases have included hydrodynamics, morphodynamics, sedimentology, flora and vegetation and faunistic population inventories, especially in the macrozoobenthos and among wading and water birds.

The National Park Authority is member of "Terramare, Institute for Coastal and Shallow Sea Research" in Wilhelmshaven, a scientific "umbrella" institution of the coastal and marine research instituts of Niedersachsen. In recent years, the National Park Authority has been focussing especially on enhancing remote-sensing procedures for terrestrial habitats (dunes, salt meadows). This work is currently being intensified, and it is being expanded to include surveys of sub-littoral habitats using hydro-acoustic procedures.

Another project, "Visitor Guide to the National Park / Tidal Flats" ("Nationalpark-Watt-/Gästeführer"), offers people the opportunity to earn certification as "visitor guides to the national park" or "visitor guides to the national park / tidal flats".

The Netherlands

In the Netherlands there are several research and advisory institutes which have specific expertise that is relevant for the conservation and management of the Wadden Sea, such as Wageningen University Research Institutes IMARES (Institute for Marine Resources & Ecosystem Studies) and ALTERRA, Royal Netherlands Institute for Sea Research (NIOZ), RWS National Institute for Coastal and Marine Management (RWS RIKZ) and The University of Groningen, University of Utrecht, Institute for Marine and Atmospheric Research, WL-Delft Hydraulics, TNO, Netherlands Institute of Applied Geoscience, Radboud University Nijmegen, NIOO, Netherlands Institute for Ecology-Centre for Estuarine and Marine Ecology.

Recently, the "Wadden Sea Academy" was established as a knowledge institute with the purpose of making an inventory of the demand for scientific research in the Wadden Sea area, to coordinate its implementation and to provide information on this to a wider audience. The academy will consist of five scientific members who will work one day per week for the academy and a supportive staff. The annual budget is almost 2 mio EUR, to be financed by the Wadden Sea Fund.

In addition, there is a lot of expertise available from other private organisations active in the area, such as:

- Groninger Landschap, It Fryske Gea, Noord-Hollands Landschap, Staatsbosbeheer, Natuurmonumenten, organisations that manage parts of the Dutch Wadden Sea;
- The Wadden Sea Society, an environmental NGO promoting the protection and sustainable use of the Wadden Sea;
- The visitors centres such as Ecomare, Visitor's Centre National Park Schiermonnikoog, Nature Centre Ameland, Wadden Centre Pieterburen, Seal Rehabilitation and Research Centre Pieterburen, Nature Museum Terschelling and Information Centre Noordwester

Also, many local inhabitants, organisations and societies have substantial practical and theoretical knowledge about many aspects and phenomena characteristic for the area.

5.h Visitor facilities and statistics

Facilities

Through an extended net of information centres, visitor information systems, print and digital information and an increasing number of professional guides along the Wadden Sea, the quality of nature experience for visitors has improved significantly, benefiting both the visitors and nature. The information and interpretation centres adjacent to the nominated property are shown in Fig. 5.6. Furthermore, there is an extensive net of information tables and signs both at and within the nominated property on those locations where visitors are assumed to go and have a look at the site or follow the many trails specifically made to provide them with information and enjoyment while at the same time causing as little disturbance to the nominated property as possible.

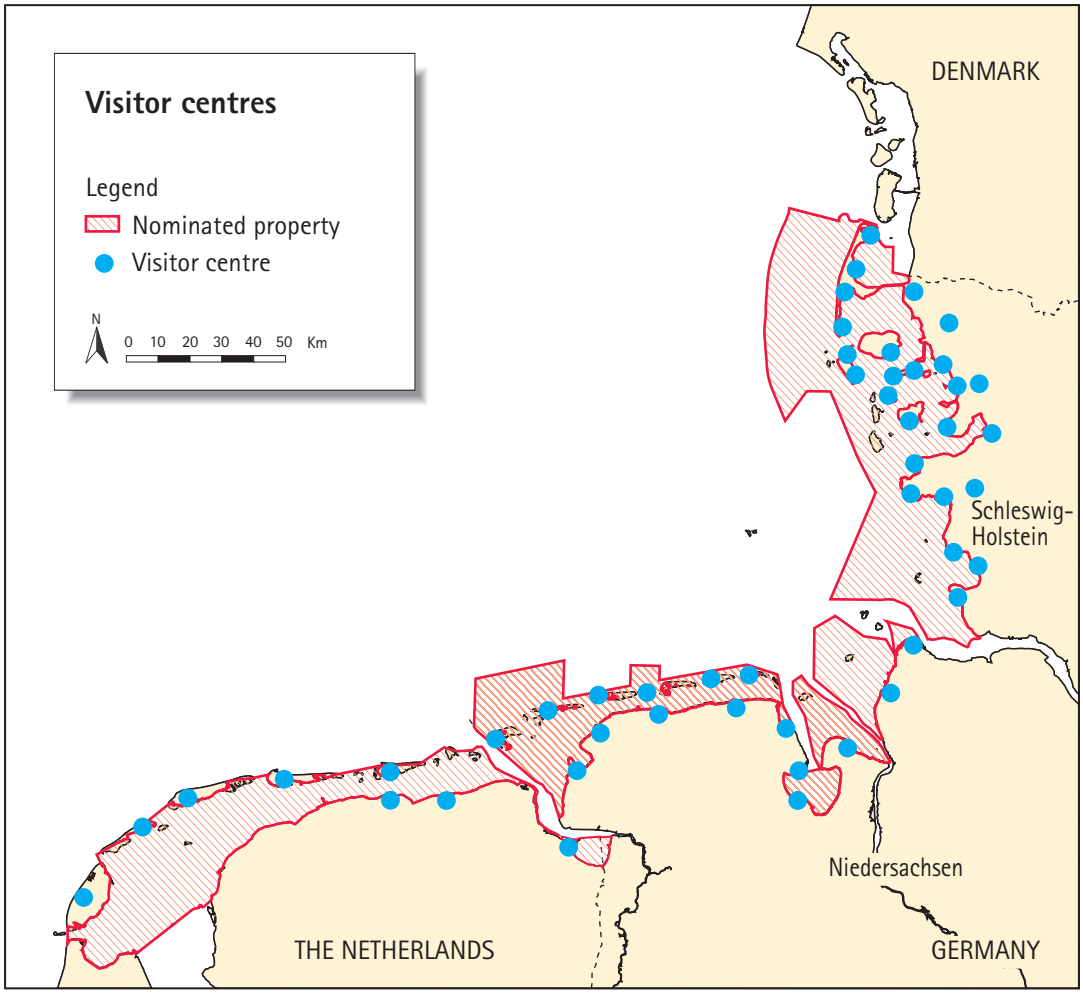


Figure 5.6:
Map of visitor centres within and adjacent to the nominated property.

Excursion with a National Park Ranger (Photo: Martin Stock).

Extensive information on the Wadden Sea, also for visitors to the nominated property, is also available electronically. The common link to all aspects of trilateral Wadden Sea matters is the website of the Common Wadden Sea Secretariat (www.waddensea-secretariat.org). The German link to the nominated property is via the national park web site (http://www.nationalpark-wattenmeer.de). This web site includes information on practically all aspects related to the protection and management of the German Wadden Sea and the activities of the national park authorities.

The Dutch link to the nominated property is via "Interwad". This organization develops and operates the website www.waddenzee.nl. This website is a focal point for information, questions, answers and opinions related to the Wadden Sea. Interwad operates with funding of the national government and the provinces and communities that are adjacent to the Wadden Sea. The objectives of Interwad are to inform people, to raise awareness and to feed the discussion on all kind of aspects related to the Wadden Sea. A number of organizations that are involved in Wadden Sea policy, are partner of Interwad.

Schleswig-Holstein

A good number of environmental education facilities are located along the coast and on the area's islands, including the Hallig islands. These facilities offer both local residents and visitors a wide range of events, guided tours and visits to relevant centres. In the "National park educational centre" (PZN) framework, a catalogue of "Learning sites in and near the national park" has been prepared that lists all of the available services in a clearly structured manner.

The information centres in and near the nominated property operate on the basis of a common concept and have coordinated their various topic emphases, and all now offer special focuses on the Wadden Sea ecosystem, along with guided tours in and near the site. The largest and most important information centre is the "Multimar Wattforum" National Park Centre in Tönning. With some 2,300 m² of exhibit space, and about 200,000 visitors yearly, it is one of the largest information centres in German protected areas and a main tourist attraction in Schleswig-Holstein. Various smaller centres scattered along the coast and on the islands are run by the National Park Service, NGO´s and municipalities, often in cooperation with each other, altogether being visited by nearly 800,000 guests per year. Some of them offer possibilities for training courses with overnight stays to schools and universities.

At the entrances to the national park, a range of pavilions, signs and maps within the visitor information system guide visitors through the area and provide information on the Wadden Sea. All of these resources have been individually tailored to their specific locations. The visitor information system (Besucherinformationssystem - BIS) provides specific information and it helps to minimize disturbances and improve protection for breeding, resting and moulting birds.

Niedersachsen

There is a total of 16 information facilities – two larger visitor centers in Wilhelmshaven and Cuxhaven as well as 14 information houses on the East Frisian Islands and on the mainland.

These facilities, which are accountable to municipal authorities, are usually run jointly with a nature conservation association. 14 of the centres currently are subsidized by the state of Niedersachsen in terms of staff costs to a total amount of about Euro 0.9 million. The number of visitors to the facilities – between 600,000 and 700,000 a year - has been consistently large for years. Groups, in particular school classes but also people on study leave, make up about 15 per cent of these visitors.

All facilities also feature a small shop where visitors can buy information leaflets and souvenirs. There are sanitary facilities available to the visitors in all information centers and houses. In addition to the 16 visitor centres mentioned above, there are 13 regional and local education and awareness centers in the area.

Information signs have been put up in places with a high frequency of visitors, for instance in the large car parks for the visitors to the islands, on landing piers for ferries or any location where nature conservation requires that visitors be looked after and directed more closely. The number of information signs currently totals about 250. Furthermore, there are nature experience trails dealing with specific subjects where the visitor can find out about environmental issues.

The administrative office of the protected area provides a large number of information brochures, which visitors can order by mail or obtain from information facilities and numerous local authorities.

The Netherlands

In and adjacent to the Wadden Sea, a broad range of educational activities is offered, such as educational walks, tours by bike, by boat or by covered wagon, lectures, presentation of films and slides, excursions on the tidal washes. At different sites in the area there are cabins for the observation of birds, information desks and marked routes.

In addition, there are several information and visitor's centres. Ecomare, Centre for Wadden and North Sea, lies in the National Park Dunes of Texel. Its objective is enlarging the public interest for the preservation and recovery of natural and cultural values (landscapes, ecosystem, species) in the Wadden region and the North Sea, with an emphasis on Texel. The centre is visited by almost 300,000 visitors each year.

Ecomare contains:

- Avisitors centre with information about nature and culture on Texel (also for the National Park);
- The first seal sanctuary in the Netherlands, with a permanent group of seals;
- Regional bird sanctuary for victims of oil slicks and other confrontations;
- A museum with extensive expositions;
- An underground Water Hall with large marine aquariums;
- A centre for nature and environmental education, with excursions and nature programs;
- An information centre for the Wadden, coast and the North Sea.

The other visitor centres on Schiermonnikoog, Ameland, Pieterburen, including the Seals Rehabilitation Centre, Terschelling, Vlieland, Lauwersmeer and Termunten are visited by almost 450,000 people annually.

At present, seven of the environmental education centres in Germany and The Netherlands (plus three centres in Denmark) work together in the International Wadden Sea School (IWSS) network. The IWSS is a cross-border educational project for school classes from the Wadden Sea countries. Initiated by the Wadden Sea Cooperation, the aim of the IWSS is to enhance the awareness of the Wadden Sea Area as a shared natural heritage and to create an understanding among young people for the need to protect and sustainably manage the Wadden Sea region as a whole.

Visitor statistics

It is particularly difficult to provide reasonable visitor statistics for the nominated property and the adjacent areas. It is difficult to discriminate between tourists and visitors to the area and statistically there is no genuinely dependable figure. Tourist statistics have been given in Chapter 4. If visitors to the nominated site and adjacent area are defined as day trippers, there are some indications as to the numbers. In Niedersachsen the number of day trippers has been estimated to amount to 16.5 million annually (2000). The number for the Schleswig-Holstein part is probably around 10 million, with a little less in the Dutch part.

More detailed information on facilities and statistics is available on request.

Boat trip on the Wadden Sea (Photo: Klass Kreuijer).

5.i Policies and programmes related to the presentation and promotion of the property

Extensive programs for promoting the Wadden Sea already exist within the framework of the current programs for promoting the national parks and the protected areas. The advertising of the nominated property will be an integral part of this promotion.

Within Germany, the property will be presented and promoted via the already existing mechanisms, amongst others the homepage www.unesco-welterbe.de. The regional presentation of the property will be done with official governmental presentations in various media, as well as on the level of ongoing activities presenting the national parks. The main communication channels are the information centres, the regional tourism organisations, the web sites of the two Wadden Sea National Parks and the linked presentation in local media. In addition, in Schleswig-Holstein it is planned to install a regional "board" for the presentation and promotion of local aspects of the Wadden Sea as a World Heritage site.

The Dutch government considers information and education important conditions for realizing its Wadden Sea policy. The information of the government aims primary at enlarging public support for its policy and at clarification of it. Regarding education, the government acts primarily as stimulator. As far as possible, the government uses nature and environmental conservation societies and visitors centres for policy communication and information. However, the government does not contribute structurally to the exploitation of these nature and environmental conservation societies and visitors centres.

In 1997, the Regional Wadden Sea Council stipulated the Frame Plan Communication Authorities Wadden Sea (KCOW). The aim of this KCOW is a professional communication by the authorities concerned which fulfils the needs of the environment. Therefore, this KCOW includes guidelines for communication activities by these authorities. Three forms of governmental communication are distinguished: policy communication, information and nature and environmental education. Also, the Interwad-platform referred to above will be used for the further promotion of the nominated property.

The Common Wadden Sea Secretariat undertakes various activities to promote the Wadden Sea, in particular in a trans-boundary context as well as internationally. The secretariat regularly publishes scientific and management reports in the "Ecosystem"-series and brochures and leaflets on various themes and topics such as World Heritage, the PSSA, coastal protection and sea level rise and cultural heritage of the area.

5.j Staffing levels (professional, technical, maintenance)

The overview of staffing level is confined to the staffing of government organizations which are directly related to the protection and management of the nominated property for its nature protection values. The overview does not include the extensive staff of non-governmental organizations working in this field notwithstanding their crucial importance for the protection of the nominated property. It is however not possible to provide an overview of the exact staffing level in this sense, since their tasks are very diverse. Neither have those organizations been included which execute normal management tasks in the nominated property such as nature managers, maintenance of shipping channels and installations for shipping safety, police tasks and other tasks vital for the overall management of the property. The overview is predominantly confined to staff directly involved in policy making and information tasks.

The national park administration in Schleswig-Holstein employs 76 professional and skilled persons, of which 16 are rangers. The staff of the administration is supported by normal police forces, and the above under 5g mentioned persons.

The National Park Authority in Niedersachsen has a staff of 28 persons. Of these, 8 are professionals and skilled in planning (landscape management) and 10 have science backgrounds (biology or geography), while 1 legal expert and 7 staff persons have general administrative duties. The staff of the administration is supported by normal police forces, and by a network of wardens from coastal authorities and counties.

The Dutch national government employs 25 policymakers (Ministry of Housing, Spatial Planning and the Environment – VROM; Ministry of Agriculture, Nature and Food Quality – LNV, Ministry of Public Works and Water Management – V&W). In addition, the national government has 14 staff members who are employed on 4 vessels for inspection and maintenance, routine research and monitoring. On a provincial level and on a local level another 6 policymakers are employed. The Regional Board for the Wadden Sea Region (RCW) and the Coordination Board of the Wadden Sea Region (CCW) employ 5 staff members. On the provincial level 4 persons are employed for inspection. The private organizations that own and/or manage parts of the Conservation Area together employ about 2 staff members and 2 rangers for activities in the area or concerning the area.

In addition to the above-mentioned organisations, a broad citizenship commitment exists. Numerous volunteers from non-governmental organisations are active in the Wadden Sea in supporting state organisations.

Governments/Authorities	Staff
Germany: National Park Authorities and Services (wardens, information centres)	159
The Netherlands: National government, regional and local coordination	54
Common Wadden Sea Secretariat	6
Total	**219**

Table 5.3: Overview of staffing level.

Monitoring of salt marsh vegetation (Photo: Martin Stock).

6. MONITORING

The state of conservation of the nominated property is regularly reviewed and reported within the Trilateral Monitoring and Assessment Program (TMAP) and additional monitoring carried out within the property. The TMAP is an integrated common monitoring program of the Wadden Sea states the Netherlands, Germany and Denmark (§ 33, Ministerial Declaration, 6th Trilateral Governmental Conference, 1991).

The aims of the TMAP are:

- To provide a scientific assessment of the status and development of the Wadden Sea ecosystem;
- To assess the status of implementation of the trilateral Targets of the Wadden Sea Plan;
- To propose management measures as consequence of the scientific assessment.

The TMAP consists of a "Common Package" of monitoring parameters including an associated data handling system which was adopted at the 8th Trilateral Governmental Conference in 1997 (Table 6.1).

Based on trilateral decisions dating back to the 1991 Ministerial Conference, Germany as well as the Netherlands have designated reference areas in the Wadden Sea. The Schleswig-Holstein reference area is the zero-use zone of 12,500 ha

Table 6.1: Overview of the TMAP Common Package parameters (adopted at the Trilateral Governmental Conference 1997). The data are exchanged via TMAP Data Units in each country for trilateral assessment such as the Quality Status Report.

<table>
<tr><th colspan="3">Common Package of TMAP Parameters</th></tr>
<tr><td>Chemical Parameters:
Nutrients
Metals in sediment
Contaminants in blue mussels, flounders and birds eggs
TBT in water and sediment</td><td rowspan="2">Biological Parameters:
Phytoplankton
Macroalgae
Eelgrass
Macrozoobenthos
Breeding birds
Migratory birds
Beached Birds Survey
Common Seals
Grey Seals</td><td>Human Use Parameters:
Fishery
Recreational activities
Agriculture
Coastal protection</td></tr>
<tr><td>Habitat Parameters:
Blue Mussel beds
Salt marshes
Beaches and Dunes</td><td>General Parameters:
Geomorphology
Flooding
Land use
Weather conditions
Hydrology</td></tr>
<tr><th colspan="3">Data Handling</th></tr>
<tr><td>Data Unit The Netherlands</td><td>Data Units Niedersachsen and Schleswig-Holstein/Hamburg</td><td>Data Unit Denmark</td></tr>
<tr><th colspan="3">Assessment</th></tr>
<tr><td colspan="3">Thematic Reports, Quality Status Reports (QSR)</td></tr>
</table>

Table 6.2: Overview of parameters, periodicity, monitoring areas and locations of record according to the TMAP Manual (May 2004).

Indicator	Parameter Group	Parameters	Periodicity	Area	Location of records
Nutrients	Nutrients in Water	Inorganic nutrients, total P, N, silicate	Monthly / every 14 days (depends on location)	8 Sub areas	TMAP Database
Contaminants in Water and Sediment	Metals in Sediment	Cd, Cu, Hag, Pb, Zn	Every 3 years (minimum)	3 sites per country (min.)	TMAP Database
	TBT in Water and Sediment	TBT substances	Yearly	Sites to be selected by each country (Hot spots)	TMAP Database
Plankton	Phytoplankton	Number of main species, chlorophyll (biomass), co-variables	Every week or 2 weeks (depends on season and location)	Existing sampling sites (status 1997), additional sites recommended (map)	TMAP Database
Benthos	Macroalgae	Location, area, coverage, biomass	Yearly / 4-6 surveys per year if necessary	All intertidal flats, selected areas for ground truth	TMAP Database
	Eelgrass	Location, area, coverage, biomass	Yearly	All intertidal flats, selected areas for ground truth	TMAP Database
	Macrozoobenthos communities	Species abundance, biomass	2 times per year	Specific sites in each country	TMAP Database
	Blue mussels beds	GIS contours of beds, additional parameters for selected beds (field surveys)	Yearly	All intertidal flats	TMAP Database
	Contaminants in Blue mussels	Heavy metals, organochlorines	Yearly	Specific sites in each country	TMAP Database
Fish	Contaminants in flounder	Heavy metals, organochlorines	Yearly	1 – 2 sites per country (to be selected on national level).	TMAP Database
	Fishery parameters	Landings, vessels, size of culture lots, size of closed area	Yearly	Whole area	TMAP Database
Birds	Breeding birds	Counts in a number of census areas, Complete survey of selected species Counts of a larger range of species	Yearly Yearly Every 5 years	Census areas Whole area Whole area	TMAP Database TMAP Database TMAP Database
	Migratory birds	Complete survey Synchronous counts (certain species) Spring tide counts	Yearly (mid-winter plus additional month) Once per year (different time of the year per species) Monthly	Whole area Whole area Selected areas	TMAP Database TMAP Database TMAP Database
	Contaminants in bird eggs	Heavy metals, organochlorines	Yearly	Specific sites in each country.	TMAP Database
	Beached birds survey	Number of beached birds, oiled birds, co-variables	Yearly	Representative stretches (4-10 sub-regions per country)	TMAP Database
Seals	Seal population	Seal numbers and distribution	Yearly (5 – 8 surveys)	Whole area	TMAP Database
Salt Marshes	Location and area of salt marshes	Zonation (6 types) and main vegetation types (25 types)	Every 5 – 7 years	Whole area	TMAP Database
	Agricultural utilization of salt marshes	Grazing and drainage types (3 categories)	Yearly / every 5 years	Whole area	TMAP Database
Beaches and Dunes	Location and area of beaches and dunes	Dune succession types (14 main types)	Every 5 – 7 years	Whole area	TMAP Database
Recreational Activities	Human activities	Numbers of boats at sea (all types) number of flat walker (guided tours)	Yearly	Whole area	TMAP Database
	Air traffic	Number of landings and take offs (all types)	Per month and year	Airports adjacent to the Wadden Sea (islands and mainland coast)	TMAP Database
General parameters	Geomorphology	Area tidal flats, sediment types, elevation	Every 5 –10 years	Whole area	Data record in the responsible institutions
	Hydrology / Flooding	Sea level, salt marsh flooding, wave climate	(Different frequencies)	Selected sites (at least one per country)	
	Weather conditions	Water and air temperature, wind, ice coverage, NAO index	Daily or monthly averages	Selected sites (existing weather stations)	
	Coastal protection measures	All relevant measures	Reporting every 5 years	Whole area	
	Land use	Agricultural use (main types).	Every 5 –10 years	Whole area	

(about 3% of the National Park), which is located south of the Hindenburg causeway. The area will also serve as a reference area with respect to the coastal water bodies implementing the EU Water Framework Directive. In Niedersachsen no official reference area has been established up to now, but large areas e.g. the islands of Mellum and Memmert and surrounding flats, and the Hohe Knechtsand area are without any human use.

In the Netherlands, a reference area in the eastern part of the Dutch Wadden Sea has been designated. It is an area of 7,400 ha (3% of the Dutch Wadden Sea), which is part of a larger area that had already been closed for shellfish fishery for a longer period. The reference area is closed for almost all human activities, including all fishery activities and all other resource exploitation.

6.a Key indicators for measuring state of conservation

TMAP parameters

The TMAP Common Package covers the entire Wadden Sea and spans a broad range from physiological processes (e.g. the effects of eutrophication) over population development (e.g. of seals, breeding and migratory birds) to changes in landscape and morphology (e.g. tidal flats, salt marshes and dunes). Furthermore, the TMAP considers the relevant EU Directives (Birds and Habitats, and Water Framework), as well as obligations from other international conventions like the Ramsar Convention, the Bonn Convention, and the OSPAR Convention. The TMAP objectives and structure, the TMAP monitoring guidelines and the TMAP data management are outlined and specified in the TMAP Manual.

Data handling

An elementary component of the TMAP is the common data handling, which makes monitoring data available for trilateral assessment. For this purpose, identical TMAP Data Units have been installed in each country. The monitoring data are available in a harmonized way and all the information which is necessary for the interpretation of the data is part of the database. Beside storage and maintenance, the TMAP data handling system also has the aim to exchange monitoring data in a common format which can be used directly in the trilateral assessment work. An overview of the data can be found in the data catalogue, which can also be accessed via the website of the Common Wadden Sea Secretariat. The TMAP, including the data handling system, serves the following tasks:

- Preparation of Quality Status Reports encompassing the most recent data and developments;
- Preparation of trilateral reports on specific topics (thematic reports, like breeding birds, migratory birds, seals, contaminants);
- Preparation of reports on unforeseeable events;
- Safeguarding long-term storage of relevant Wadden Sea data;
- Use of trilateral data for national and international programs.

The TMAP data handling system is also a valuable instrument for other reporting obligations (e.g. national status reports, EU reports concerning Natura 2000 and the Water Framework Directive, international reports concerning OSPAR, RAMSAR or other international conventions) by providing up-to-date and harmonized Wadden Sea data from different sources on the national and international level.

Additionally, the TMAP data handling system enhances the possibilities to present monitoring data to relevant authorities, interest groups and local citizens in accordance with the trilateral Wadden Sea Plan (Chapter 1, §15). In 2004, the TMAP data handling was evaluated by an external consultant (Orbis Institute, Canada). The Orbis Report concluded that the TMAP data handling is an effective tool in providing the required data at reasonable costs.

The TMAP and the associated data handling has recently been further developed to meet the requirements of the European Union Directives and other international obligations.

Additional monitoring

There are several national and regional monitoring programs, which are formally not part of the TMAP Common Package but deliver important information for the overall assessment of the nominated property and are also included in the regular Quality Status Reports. These are e.g. the monitoring carried out in connection with the exploitation of natural gas in the Dutch part of the nominated property, in particular with regard to subsidence, the monitoring of tourism and recreational activities in a wider context as included in the Common Package, the monitoring of human use of coastal waters on birds, the monitoring of fish fauna and epifauna in the western part of the Wadden Sea, the monitoring of demersal fish, the

Monitoring of salt marsh vegetation (Photo: Martin Stock).

monitoring of molluscs (littoral monitoring and beach monitoring), the monitoring of salt marshes (silt accretion, water levels, soil subsidence, vegetation), the biomass monitoring of blue mussel beds and of certain species.

6.b Administrative arrangements for monitoring property

The Trilateral Monitoring and Assessment Group (TMAG) is responsible for implementation and coordination of the TMAP. The TMAG consists of two to three delegates from the national administrations responsible for the coordination of the national monitoring programs and data management. Technical groups, like the Trilateral Data Handling Group (TDG), the Coordinator Group on the Joint Monitoring Program for Breeding Birds (JMBB) and the Coordinator Group on the Joint Monitoring Program for Migratory Birds (JMMB) have been installed under the responsibility of the TMAG.

The Common Wadden Sea Secretariat (CWSS) is the secretariat for the trilateral Wadden Sea cooperation, including the TMAP. In the framework of the TMAP, the secretariat is responsible for the day-to-day management of the program and the preparation of the meetings of the TMAG and of the technical monitoring groups.

The TMAP is carried out by national and regional authorities in charge of monitoring.

Table 6.3: Overview of institutions in charge of the TMAP Wadden Sea monitoring in Germany and The Netherlands.

Country	Responsible Ministry	Responsible authority
Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety	Federal Agency for Nature Conservation
	Schleswig-Holstein State Ministry for Agriculture, Rural Areas and Nature	National Park Authority, LANU
	Niedersachsen State Ministry for Environment	National Park Authority, NLWKN
The Netherlands	Ministry of Agriculture, Nature and Food Quality	Ministry of Agriculture, Nature and Food Quality, Regional Policy Department Northern Office
	Ministry of Public Works and Water Management.	Centre for Water Management

6.c Results of previous reporting exercises

Assessment reports

Related to the Trilateral Governmental Conferences (every 3 to 4 years), Quality Status Reports of the Wadden Sea are elaborated. They describe and evaluate the current ecological status of the Wadden Sea, identify issues of concern and indicate possible measures. In March 2005, the latest Quality Status Report (QSR 2004) of the Wadden Sea was published. After 1991, 1995 and 1999 it was the fourth time that a comprehensive, integrated assessment of the Wadden Sea could be presented. Additionally, the results of the TMAP are published in workshop reports, thematic reports (the series "Wadden Sea Ecosystem") (see below) and in the "Wadden Sea Newsletter".

All reports are available from the Common Wadden Sea Secretariat (Quality Status Report 1999 see **Annex 07** and Quality Status Report 2004 see **Annex 08**):

http://www.waddensea-secretariat.org/news/publications/publ.html

TMAP reports in the publication series "Wadden Sea Ecosystem"

Reineking, B. & Südbeck, P., 2007 (Eds.). Seriously Declining Trends in Migratory Waterbirds: Causes-Concerns-Consequences. Proceedings of the International Workshop on 31 August 2006 in Wilhelmshaven, Germany. Wadden Sea Ecosystem No. 23.

Koffijberg, K., Dijksen, L., Hälterlein, B., Laursen, K., Potel, P. & Südbeck, P., 2006. Breeding Birds in the Wadden Sea in 2001. Results of the total survey in 2001 and trends in numbers between 1991 and 2001. Wadden Sea Ecosystem No. 22.

Blew, J. & Südbeck, P. (Eds.), 2005. Migratory Waterbirds in the Wadden Sea 1980- 2000. Wadden Sea Ecosystem No. 20.

Essink, K., C. Dettmann, H. Farke, K. Laursen, G. Lüerßen, H. Marencic, W. Wiersinga (Eds.), 2005. Wadden Sea Quality Status Report 2004. Wadden Sea Ecosystem No. 19.

Becker, Peter H. & Jacqueline Muñoz Cifuentes, 2004. Contaminants in Bird Eggs in the Wadden Sea. Recent Spatial and Temporal Trends. Seabirds at Risk? Effects of Environmental Chemicals on Reproductive Success and Mass Growth at the Wadden Sea in the Mid 1990s. Wadden Sea Ecosystem No. 18.

CWSS (publisher), 2003. Management of North Sea Harbour and Grey Seal Populations. Proceedings of the International Symposium at EcoMare, Texel, November 29 - 30, 2003.Wadden Sea Ecosystem, No. 17.

Koffijberg, K., J. Blew, K. Eskildsen, K. Günther, B. Koks, K. Laursen, L.M. Rasmussen, P. Potel, P. Südbeck, 2003. High Tide Roosts in the Wadden Sea. A Review of Bird Distribution, Protection Regimes and Potential Sources of Anthropogenic Disturbance. Wadden Sea Ecosystem No. 16.

Beusekom, J.E.E., van, H. Fock, F. de Jong, S. Diehl-Christiansen, B. Christiansen, 2001. Wadden Sea Specific Eutrophication Criteria. Wadden Sea Ecosystem No. 14.

Becker, Peter H. , Jacqueline Muñoz Cifuentes, Brigtte Behrends, & Klaus R. Schmieder, 2001. Contaminants in Bird Eggs in the Wadden Sea. Spatial and Temporal Trends 1991-2000. Wadden Sea Ecosystem No. 11.

Lars Maltha Rasmussen, David M. Fleet, Bernd Hälterlein, Ben J,. Koks, Petra Potel &Peter Südbeck, 2000. Breeding Birds in the Wadden Sea in 1996. Results of a total survey in 1996 and of numbers of colony breeding species between 1991 and 1996. Wadden Sea Ecosystem No. 10.

Folkert de Jong, Joop Bakker, Kees van Berkel, Norbert Dankers, Karsten Dahl, Christiane Gätje, Harald Marencic & Petra Potel, 1999. Wadden Sea Quality Status Report 1999. Wadden Sea Ecosystem No. 9.

Thyen, Stefan, Peter H. Becker, Klaus-Michael Exo, Bernd Hälterlein, Hermann Hötker & Peter Südbeck, 1998. Monitoring Breeding Success of Coastal Birds. Wadden Sea Ecosystem No. 8.

Becker, Peter H., Stefan Thyen, Susanne Mickstein, Ute Sommer & Klaus R. Schneider, 1998. Monitoring Pollutants in Coastal Bird Eggs in the Wadden Sea. Wadden Sea Ecosystem No. 8.

Bakker, Joop, Norbert Dankers, Folkert de Jong, Christiane Gätje, Torben Pedersen, Petra Potel, Kees van Berkel, 1997. Assessment Report of the Wadden Sea Ecosystem. Wadden Sea Ecosystem No. 7.

Marencic, H., J. Bakker, H. Farke, C. Gätje, A. Kellermann, F. de Jong, K. Laursen, T. Pedersen & J. de Vlas, 1996.TMAP Expert Workshops in 1995 / 1996. **The Trilateral Monitoring and Assessment Program.** Wadden Sea Ecosystem No. 6.

Poot, M., Lars Maltha Rasmussen, Marc van Roomen, Hans-Ulrich Rösner & Peter Südbeck, 1996. Migratory Waterbirds in the Wadden Sea 1993/1994.Wadden Sea Ecosystem No. 5.

Melter, J., Peter Südbeck, David M. Fleet, Lars Maltha Rasmussen, Rob L. Vogel, 1997. Breeding Birds on Census Areas 1990 until 1994. Wadden Sea Ecosystem No. 4.

Dierschke, J., 1997. Status of Shorelark, Twite and Snow Bunting in the Wadden Sea. Wadden Sea Ecosystem No. 4.

Hälterlein, D., D.M. Fleet, H.R. Henneberg, Th. Mennebaeck, L. M. Rasmussen, P. Suedbeck, O. Thorup & R. L. Vogel, 1995. Guidelines for Monitoring of Breeding Birds in the Wadden Sea -Summary (in Dutch, German, Danish). Wadden Sea Ecosystem No. 3.

Rösner, H.U., M. v. Roomen, P. Suedbeck & L. M. Rasmussen, 1994. Migratory Waterbirds in the Wadden Sea 1992/93. Wadden Sea Ecosystem No. 2.

Fleet, D. M., J. Frikke, P. Suedbeck & R. L. Vogel, 1994. **Breeding Birds in the Wadden Sea 1991.** Wadden Sea Ecosystem No. 1.

7. DOCUMENTATION

7.a Photographs, slides, image inventory and authorization table and other audiovisual materials

An image inventory, including the photograph and audiovisual authorization form is given in **Annex 23**.

The photographs and a slideshow about the Wadden Sea are compiled on a DVD (**Annex 24**). (Annex 23 and 24 are only part of the original dossier, which was sent to UNESCO)

7.b Texts relating to protective designation, copies of property management plans or documented management systems and extracts of other plans relevant to the property

Trilateral level

Joint Declaration on the Protection of the Wadden Sea (1982), **Annex 10**.

Administrative Agreement (1987), **Annex 11**.

Stade Declaration, Trilateral Wadden Sea Plan (1997), **Annex 12**.

Agreement on the Conservation of Seals in the Wadden Sea according to Article 4 of the Convention on the Conservation of Migratory Species of Wild Animals (CMS, Bonn Convention, 1990), **Annex 13**.

Designation of the Wadden Sea as Particularly Sensitive Sea Area (PSSA) by the International Maritime Organization, 2002, **Annex 14**.

Further documents of the Trilateral Cooperation on the Protection of the Wadden Sea, including the ministerial declarations 1991, 1994, 1997, 2001 and 2005 are available from the website of the Common Wadden Sea Secretariat www.waddensea-secretariat.org

The Netherlands

Nature Conservation Act, 1998, **Annex 15**.

Third Wadden Sea memorandum (Derde Nota Waddenzee) Key Planning Decision (PKB), **Annex 16**.

Germany

The Federal Nature Conservation Act constitutes the framework legislation to be enacted by the federal government and the corresponding acts by the states. The actual versions of the acts can be obtained via www.bmu.de. Of special importance to the Wadden Sea are the National Park Acts.

The legal foundations of the three National Parks in the German Wadden Sea, constituting the proposed world heritage site in Germany are:

Niedersachsen

Act for amendment of the Act on the National Park "Wadden Sea of Niedersachsen" of 11 July 2001.(Law Gazette of Niedersachsen (Nds. GVBl.) p. 443 – VORIS 28100 05, 28100 01, 28100 03 –), **Annex 17**.

Schleswig-Holstein

Act for Amendment of the Act for Protection of the Wadden Sea of Schleswig-Holstein (National Park Act - NPG) of 17 December 1999, **Annex 18**.

Other regional or sectoral management systems and extracts of plans (e.g. foreland management concepts, framework agreement on mussel fisheries, ordinance on maritime navigation in German Wadden Sea national parks) are listed in **Annex 19** and available upon request from the regional responsible authorities (see Chapter 8b).

7.c Form and date of most recent records or inventory of property

TMAP

All records and inventories of the nominated property according to TMAP are available, after registration, from the official web address of the TMAP:

http://www.waddensea-secretariat.org/TMAP/Monitoring.html

Additional data on national or regional level can be obtained via the regional responsible authorities (see Chapter 8b).

Quality Status Reports

The three Wadden Sea countries regularly produce joint Quality Status Reports on the basis of findings from the TMAP. These reports describe, in detail, the condition of the area's most important biotic and abiotic factors; the extent and impacts of human activities, and protection and management of the Wadden Sea region. All of these factors are evaluated in sum and, where necessary and possible, recommendations for further management in the framework of the Wadden Sea Plan are provided. The Quality Status Report covers the periodic reporting obligations of the proposed property according to the operational guidelines.

Attached are the Quality Status Reports 2004, **Annex 08** and 1999, **Annex 07**.

7.d Address where inventory, records and archives are held

The inventory records according to TMAP are held at the
Common Wadden Sea Secretariat
Virchowstr. 1
D – 26382 Wilhelmshaven
Germany
www.waddensea-secretariat.org

Additional regional inventories and data are held at the nationally or regionally responsible authorities:

The Netherlands

Centre for Water Management
Zuiderwagenplein 2
8224 AD Lelystad
The Netherlands
www.rijkswaterstaat.nl

Germany

Niedersachsen

Nationalparkverwaltung Niedersächsisches Wattenmeer
Virchowstr. 1
D- 26382 Wilhelmshaven
www.nationalpark-wattenmeer.de

Schleswig-Holstein

Landesbetrieb für Küstenschutz, Nationalpark und Meeresschutz,
Nationalparkverwaltung
Schlossgarten 1
D – 25832 Tönning
www.nationalpark-wattenmeer.de

7.e Bibliography

A list of references for this nomination is provided below. This is a small part of the large scientific literature which exists for the nominated property. A provisional bibliography for the nominated property, containing over 700 references is provided as **Annex 09** to this nomination.

Adolph, W., Jaklin, S., Meemken, M. and Michaelis, H., 2003. Die Seegrasbestände der niedersächischen Watten 2000-2002. Niedersächisches Landesamt Ökologie, Forschungsstelle Küste, Norderney, Germany.

Bakker, J.F., Bartelds, W., Becker, P.H., Bester K., Dijkhuizen, D., Frederiks, B., Reineking, B., 1999. Marine Chemistry. In:, Jong, F. de, Bakker, J.F., van Berkel, C.J.M., Dankers, N.M.J.A., Dahl, K., Gätje, C., Marencic, H. and Potel, P. (Eds.), 1999 Wadden Sea Quality Status Report. Wadden Sea Ecosystem No. 9. Common Wadden Sea Secretariat, Trilateral Monitoring and Assessment Group, Quality Status Report Group. Wilhelmshaven.

Bakker, J.P., Kuijper, D.P.J., van Wijnen, H.J., de Groot, A.V. and de Vries, Y., 2004. Spatio-temporal variation in surface elevation changes in back barrier salt marshes in the Wadden Sea. Geografisk Tidsskrift.

Bakker, J.P. and Piersma, T., 2005. Restoration of intertidal flats and tidal salt marshes. In: Restoration ecology. The New Frontier. Edited by Andel, J. van and Aronson, J., Blackwell Science, Oxford. pp. 174-192.

Baptist, H.J.M. and Wolf, P.A., 1993. Atlas van de vogels van het Nederlands continentaal plat. Rapport DGW-93.012. Ministerie van Verkeer en Waterstaat.

Becker, P.H., Furness, R.W. and Tasker, M.L, 2003. Seabirds as monitors of marine pollution. In: Furness, R.W. and Tasker, M.L., (Eds.), Seabirds as monitors of the marine environment. ICES Coop. Res. Report No. 258: 3-25.

Beukema, J.J., 2002. Expected changes in the benthic fauna of Wadden Sea tidal flats as a result of sea level rise or bottom subsidence. J. Sea. Res. 47: 25-39.

Beusekom, J.E.E. van, 2005. Eutrophication history of the Wadden Sea. Helgoland Mar. Res 59: 5–54.

Blew, J., Günther, K., Laursen, K., Roomen, M. van, Südbeck, P., Eskildsen, K. and Potel, P. 2007. Trends of waterbird populations in the International Wadden Sea 1987-2004 – An update. P. 9-42 in Reineking, B. and Südbeck, P. (eds.). Seriously declin-

ing trends in migratory waterbirds: Causes-Concerns-Consequences. Proceedings of the International Workshop on 31 August 2006 in Wilhelmshaven, Germany. Wadden Sea Ecosystems No. 23. Common Wadden Sea Secretariat, Wadden Sea National Park of Lower Saxony, Institute of Avian Research, Joint Monitoring Group of Migratory Birds in the Wadden Sea, Wilhelmshaven, Germany.

Blew, J., Günther K., Laursen, K., van Roomen, M., Südbeck, P., Eskildsen, K., Potel, P. and Rösner, H.U. (eds.), 2005. Overview of Numbers and Trends of Migratory Waterbirds in the Wadden Sea 1980-2000. Wadden Sea Ecosystem No. 20, Common Wadden Sea Secretariat, Trilateral Monitoring and Assessment Group, Joint Monitoring Group of Migratory Birds in the Wadden Sea, Wilhelmshaven, FRG.

Boddeke, R., Daan, N., Posthuma, K.H., Veen, J.F. de and Zijlstra, J.J., 1969. A census of juvenile demersal fish in the Dutch Wadden Sea, the Zeeland nursery ground, the Dutch coastal area and the open sea areas off the coasts of The Netherlands, Germany and the southern part of Denmark. Ann. biol. Copenhagen 26, 269-275.

Cadée, G.C. and Hegeman, J., 2002. Phytoplankton in the Marsdiep at the end of the 20th century; 30 years monitoring biomass, primary production and Phaeocystis blooms. J. Sea Res. 48, 97-110.

Camphuysen, C.J. and Leopold, M.F., 1994. Atlas of seabirds in the Southern North Sea. IBN Research Report 94/6. NIOZ-Report 1994-8, Institute for Forestry and Nature Research, Dutch Seabird Group and Netherlands Institute for Sea Research, Texel, pp. 12.

Camphuysen, C.J. and Garthe, S., 2000. Seabirds and commercial fisheries: population trends of piscivorous seabirds explained? In: Kaiser M.J. and Groot S.J. de, (Eds.). Effects of fishing on non-target species and habitats: Biological, Conservation and Socio-Economic Issues, Blackwell Science, Oxford, 163-184.

Carter, R.W.G., 1989. Coastal environments. Academic Press, London, pp. 617.

Cowi, 2004. Report and assessment of socio-economic data in the Danish sector of the Wadden Sea Region. Wadden Sea Forum Report No. 2, 36 pp.

CPSL, 2001. Coastal protection and sea level rise. Final report of the trilateral working group on coastal protection and sea level rise (CPSL). Wadden Sea Ecosystem No. 13, Common Wadden Sea Secretariat, Wilhelmshaven, Germany.

CPSL, 2005. Coastal Protection and Sea Level Rise – Solutions for sustainable coastal protection in the Wadden Sea region. Wadden Sea Ecosystem 21. Common Wadden Sea Secretariat Wilhelmshaven.

Dalfsen, J.A. and K. Essink, 1997. Risk analysis of coastal nourishment techniques. RIKZ Report 97.022. RIKZ, Haren.

Delafontaine, M.T., Flemming, B.W. and Mai, S., 2000. The Wadden Sea squeeze as a cause of decreasing sedimentary organic loading. In: Flemming, B.W., Delafontaine, M.T. and Liebezeit, G. (Eds.). Muddy coast dynamics and resource management. Elsevier Science, pp. 273-286.

Dijkema, K.S. (Ed.), Beeftink, W.G., Doody, J.P., Gehu, J.M. Heydemann, B. and Rivas Martinez, S., 1984. Salt marshes in Europe. Council of Europe. Nature and Environment Series 30, Strasbourg, pp. 178.

Dijkema, K.J., 1987. Geography of salt marshes in Europe. Z. Geomorph. N.F. 31: 489-499.

Dijkema, K.S., 1989. Habitats of The Netherlands, German and Danish Wadden Sea. 24 maps 1: 100,000 and legend. Research Institute for Nature Management, Texel and Veth foundation, Leiden.

Elliott, M. and Hemingway, K.L., 2002. Fishes in estuaries, London: Blackwell science, pp. 636.

Enemark J.A., 1993. The protection of the Wadden Sea in an international perspective. Planning, protection and management of the Wadden Sea. In: Hillen R, Verhagen HJ (eds). Coastlines of the Southern North Sea. pp. 202–213.

Enemark, J.A., 2005. The Wadden Sea protection and management scheme. Towards an integrated coastal management approach? Ocean & Coastal Management 48: 996–1015.

Ens, B., Smaal, A.C. and de Vlas, J., 2004. The effects of shellfish fishery on the ecosystems of the Dutch Wadden Sea and Oosterschelde. Final report of the second phase of the scientific evaluation of the Dutch selfish fishery policy (EVAII). Alterrra-rapport 1011; RIVO-rapport C056/04; RIKZ-rapport RKZ/2004.031. Alterra, Wageningen 2004, pp. 212.

Esselink, P., 2000. Nature management of coastal salt marshes. Interactions between anthropogenic influences and natural dynamics. Ph.D. thesis University of Groningen, 256 p.

Esselink, P., De Leeuw, C., Graveland, J., and Berg, G.J., 2003. Ecologische herstelmaatregelen in zoute wateren. Een ecologische evaluatie over de periode 1990 – 2000. rapport RIKZ/2003.028, Rijksinstituut voor Kust en Zee, Middelburg.

Essink, K., Dettmann, C., Farke, H., Laursen, K., Leinfelder, R., Lüerßen, G., Marencic, H. and Wiersinga, W. (Eds.) 2005: Wadden Sea Quality Status Report 2004. Wadden Sea Ecosystems No. 19, Common Wadden Sea Secretariat, Wilhelmshaven, Trilateral Monitoring and Assessment Group, Wilhelmshaven, Germany.

Fleet, D.M., Frikke J., Südbeck P. and Vogel, R.L., 1994. Breeding birds in the Wadden Sea 1991. Wadden Sea Ecosystem No. 1. Common Wadden Sea Secretariat, Wilhelmshaven.

Flemming, B.W. and Davis, R.A., 1994. Holocene evolution, morphodynamics and sedimentology of the Spiekeroog barrier island system (southern North Sea). Senckenberg maritima 24: 117-155.

Flemming, B.W. and Nyandwi, N., 1994. Land reclamation as a cause of fine-grained sediment depletion in backbarrier tidal flats, southern North Sea. Neth J Aquat Ecol 28: 299-307.

Flemming, B.W., 2002. Effects of climate and human interventions on the evolution of the Wadden Sea depositional system (southern North Sea). In: Wefer, G., Berger, W., Behre, K.E., Jansen, E. (Eds.). Climate development and history of the North Atlantic realm. Springer-Verlag, Heidelberg, 399-413.

Hammond, P.S., Berggren, P., Benke, H., Borchers, D.L., Collet, A., Heide-Jørgensen, M.P., Heimlich-Boran, S., Hiby, A.R., Leopold, M.F. and Øien, N., 2002. Abundance of harbour porpoise and other cetaceans in the North Sea and adjacent waters. J. Appl. Ecol. 39, 361-376.

Hartog, C. den, and Phillips, R.C., 2001. Common structures and properties of seagrass beds fringing the coasts of the world. In: Reise, K., (Ed.). Ecological comparisons of sedimentary shores. Ecological Studies 151. Springer-Verlag, Berlin Heidelberg: 195-212.

Heydemann, B., 1981. Ecology of arthropods of the lower salt marsh. In: Dankers, N, Kühl, H. and Wolff, W.J. (Eds.). Invertebrate fauna of the Wadden Sea. Report 4 of the Wadden Sea Working Group. Balkema, Rotterdam, pp. 35 – 57.

Hofstede, J.L.A., 1991. Sea level rise in the inner German Bight (Germany) since AD 600 and its implications upon tidal flats geomorphology. In: Brückner, H. and Radtke, U. (Eds.). From

the North Sea to the Indian Ocean. Franz Steiner Verlag, Stuttgart, pp. 11-27.

Hofstede, J.L.A., 2003. Integrated management of artificially created salt marshes in the Wadden Sea of Schleswig-Holstein, Germany. Wetlands Ecology and Management 11/3, 183-194.

Janssen, J., 2001. Mapping of salt marsh vegetation by sequential mapping. Rijskwaterstaat Meetkundige Dienst Delft, pp. 249.

Jong, F. de., 1998. Marine ecological quality objectives: Science and management aspects. In: Müller F, Leupelt M (eds) Eco-Targets, Goal Functions and Orientors. Springer, Berlin, Heidelberg. pp 526–544

Jong, F. de, 2003. Wadden Sea targets: lessons from the first six years. pp. 207-220 in: Wolff WJ, Essink K, Kellermann A, Van Leeuw MA (Eds.). Challenges to the Wadden Sea Area. Proceedings of the 10th International Scientific Wadden Sea Symposium. Ministry of Agriculture Nature Management and Fisheries, Department of Marine Biology, University of Groningen, Netherlands.

Jonge, V.N. de, Essink, K. and Boddeke, R., 1993. The Dutch Wadden Sea: A changed ecosystem. Hydrobiologia 265, 45-71.

Koffijberg, K., Blew J., Eskildsen, K., Günther, K., Koks, B., Laursen, K., Rasmussen, L.-M., Südbeck, P. and Potel, P., 2003. High tide roosts in the Wadden Sea: A review of bird distribution, protection regimes and potential sources of anthropogenic disturbance. A report of the Wadden Sea Plan Project 34. Wadden Sea Ecosystems No. 16, Common Wadden Sea Secretariat, Trilateral Monitoring and Assessment Group, JMMB Wilhelmshaven, Germany, pp. 119.

Koffijberg, K., Dijksen, L., Hälterlein, B., Koffijberg, K., Laursen, K., Potel, P. and Südbeck, P. (Eds.) 2006. Breeding Birds in the Wadden Sea in 2001. Results of a total survey in 2001 and trends in numbers between 1990-2001. Wadden Sea Ecosystem No. 22; Common Wadden Sea Secretariat, Trilateral Monitoring and Assessment Group, Joint Monitoring Group of Breeding Birds in the Wadden Sea, Wilhelmshaven, Germany. pp. 136.

Koopmann, C., Faller, J., Bernem, K.-H. van, Prange, A. and Müller, A., 1993. Schadstoffkartierung in Sedimenten des deutschen Wattenmeeres Juni 1989-Juni 1992. GKSS 88.156.

Lozan, J.L., Rachor, E., Reise, K., Sündermann, J. and Westenhagen, H.v., 2002. Warnsignale aus Nordsee und Wattenmeer eine aktuelle Umweltbilanz. Wissenschaftliche Auswertungen, Hamburg.

Marencic, H., Bakker, J., Farke, H., Gätje, C., de Jong, F., Kellermann, A., Laursen, K., Pedersen, T.F. and J. de Vlas, 1996. The Trilateral Monitoring and Assessment Program (TMAP). Expert Workshops 1995/96. Wadden Sea Ecosystem No. 6. - Common Wadden Sea Secretariat and Trilateral Monitoring and Assessment Group, Wilhelmshaven, Germany.

Moser, M. and Brown, A., 2007. Trilateral Wadden Sea cooperation. External Evaluation Report. CWSS, Wilhelmshaven.

Nordheim, H. von, Norden Anderson, O. and Thiessen, J. (Eds.), 1996. Red List of Biotopes, Flora and Fauna of the Trilateral Wadden Sea Area, 1995. Helgoländer Meeresunters. 50, (Suppl.).

Oost, A.P., Ens, B.J., Brinkman, A.G., Dijkema, K.S., Eysink, W.D., Beukema, J.J., Gussinklo, H.J., Verboom, B.M.J., Verburgh, J.J., 1998. Integrale Bodemdalingsstudie Waddenzee. Nederlandse Aardolie Maatschappij B.V., Assen, 372 pp.

PROGNOS, 2004. Sector-specific analysis and perspectives for the Wadden Sea Region. Part two: sector-specific analysis. Wadden Sea Forum Report No. 8, November 2004, 197 pp.

Reijnders, P.J.H., Brasseur, S.M.J.M. and Brinkman, A.G., 2003. The phocine distemper virus outbreak of 2002 amongst harbour seals in the North Sea and Baltic Sea: spatial and temporal development, and predicted population consequences. In: Management of North Sea harbour and grey seal populations. Proceedings of the International Symposium at EcoMare, Texel, The Netherlands, November 29-30, 2002. Wadden Sea Ecosystem No. 17, Wadden Sea Secretariat, Wilhelmshaven, Germany. pp.19-25.

Reineking, B. and Südbeck, P. (Eds.), 2007. Seriously declining trends in migratory waterbirds: Causes-Concerns-Consequences. Proceedings of the International Workshop on 31 August 2006 in Wilhelmshaven, Germany. Wadden Sea Ecosystems No. 23. Common Wadden Sea Secretariat, Wadden Sea National Park of Niedersachsen, Institute of Avian Research, Joint Monitoring Group of Migratory Birds in the Wadden Sea, Wilhelmshaven, Germany.

Reise, K., 2005. Coast of change: Habitat loss and transformations in the Wadden Sea. Helgol. Mar. Res. 59 (1), p. 9 -21.

Roomen, M. van, E. van Winden, K. Koffijberg, R. Kleefstra, G. Ottens, SOVON Ganzen- en Zwanenwerkgroep, 2003. Watervogels in Nederland in 2001/2002. (In Dutch with English Summary). SOVON-monitoringrapport 2003/04, SOVON Vogelonderzoek Nederlands, Beek-Ubbergen, NL, pp. 211.

Seal Management Plan, 2002, Conservation and Management Plan for the Wadden Sea Seal Population, 2001-2006, including Additional Measures for the Protection of the Grey Seal in the Wadden Sea. In: Ministerial Declaration of the 9th Trilateral Governmental Conference on the Protection of the Wadden Sea, Esbjerg, October 31, 2001, Annex 1 (English version). Common Wadden Sea Secretariat, Wilhelmshaven, 25-37.

Rösner, H.-U., 1993. The joint monitoring project for migratory birds in the Wadden Sea. Report to the Trilateral Cooperation on the Protection of the Wadden Sea. CWSS, Wilhelmshaven, pp. 16.

Schanz, A. and Asmus, H., 2003. Impact of hydrodynamics on development and morphology of intertidal seagrasses in the Wadden Sea. Mar. Ecol. Prog. Ser. 261:123-134.

Trilateral Wadden Sea Plan, 1997. In: Ministerial Declaration of the Eighth Trilateral Governmental Conference on the Protection of the Wadden Sea, Stade, 1997, Annex 1. Common Wadden Sea Secretariat, Wilhelmshaven, pp. 13-83.

Vorberg, R. and Breckling, P., 1999. Atlas der Fische im schleswig-holsteinischen Wattenmeer. Schriftenreihe des Nationalparks Schleswig-Holsteinisches Wattenmeer, Heft 10, pp. 178.

Wadden Sea Forum, 2005. Breaking the ice. Final Report of the Wadden Sea Forum, February 2005, Wadden Sea Forum. Wilhelmshaven, Germany, pp. 72

Wolff, W.J.(Ed.), 1983. Ecology of the Wadden Sea. Balkema, Rotterdam

Zijlstra, J.J., 1978. The function of the Wadden Sea for the members of its fish-fauna. In: Dankers, N.; Wolff, W.J. and Zijlstra, J.J. (Editors). Fishes and fisheries in the Wadden Sea. Report 5 of the final report of the section 'Fishes and fisheries' of the Wadden Sea Working Group. Stichting Veth tot Steun aan Waddenonderzoek, Leiden, 20-25.

8. CONTACT INFORMATION

8.a Preparer

Jens Enemark, Secretary
Common Wadden Sea Secretariat
Virchowstr. 1
D 26382 Wilhelmshaven
phone: +49(0)4421 91080
fax: +49(0)4421 910830
enemark@waddensea-secretariat.org

8.b Official local institution/ agency

The Netherlands

Ir. H.R. Oosterveld, Head of Department
Ministry of Agriculture, Nature and Food Quality
Regional Policy Department Northern Office
6, Cascadeplein
NL 9700 RM Groningen
phone: +31(0)50 5992300
fax: +31(0)50 5992399
h.r.oosterveld@minlnv.nl

Germany

Dr. Christiane Paulus, Regierungsdirektorin
Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU)
Robert Schumann-Platz 3
D 53175 Bonn
phone: +49(0)1888 3052630
fax: +49(0)1888 3052684
christiane.paulus@bmu.bund.de

Niedersachsen

Hubertus Hebbelmann
Niedersächsisches Umweltministerium
Ref. 52 -Natura 2000, Nationalparke, Biosphärenreservate-
Archivstraße 2
D 30169 Hannover
phone: +49(0)511 1203382
fax: +49(0)511 120993382
hubertus.hebbelmann@mu.niedersachsen.de

Dr. Hubert Farke
Nationalparkverwaltung Niedersächsisches Wattenmeer
Virchowstr.1
D 26382 Wilhelmshaven
phone: +49(0)4421 911281
fax: +49(0)4421 911280
hubert.farke@nlpv-wattenmeer.niedersachsen.de

Schleswig-Holstein

Vera Knoke
Ministerium für Landwirtschaft, Umwelt und ländliche Räume des Landes Schleswig-Holstein
Ref. 43 Meeresschutz, Nationalpark
Mercatorstr. 3
D 24106 Kiel
phone: +49(0)431 9887196
fax: +49(0)431 988 6157196
vera.knoke@mlur.landsh.de

Dr. Klaus Koßmagk-Stephan
Landesbetrieb für Küstenschutz, Nationalpark und Meeresschutz,
Nationalparkverwaltung
Schlossgarten 1
D-25832 Tönning
phone: +49(0)4861 61640
fax: +49(0)4861 61651
Klaus.Kossmagk-Stephan@lkn.landsh.de

8.c Other local institutions

The Netherlands

Public Relations Official of	Address	Postal code	City	E-mail
Municipality of Anna Paulowna	PO Box 8	1760 AA	Anna Paulowna	info@annapaulowna.nl
Municipality Wieringen	PO Box 1	1777 ZG	Hippolytushoef	gem.wieringen@wieringen.nl
Municipality Den Helder	PO Box 36	1780 AA	Den Helder	info@denhelder.nl
Municipality Harlingen	PO Box 10.000	8860 HA	Harlingen	gemeentebestuur@harlingen.nl
Municipality Wûnseradiel	PO Box 2	8748 ZL	Witmarsum	info@wunseradiel.nl
Municipality Franekeradeel	PO Box 58	8800 AB	Franeker	info@franekeradeel.nl
Municipality Het Bildt	PO Box 34	9076 ZN	St. Annaparochie	info@hetbildt.nl
Municipality Ferwerderadiel	PO Box 2	9172 ZS	Ferwert	info@ferwerderadiel.nl
Municipality Dongeradeel	PO Box 1	9100 AA	Dokkum	gemeente@dongeradeel.nl
Municipality De Marne	PO Box 11	9965 ZG	Leens	gemeente@demarne.nl
Municipality Eemsmond	PO Box 11	9980 AA	Uithuizen	algemeen@eemsmond.nl
Municipality Texel	PO Box 200	1790 AE	Den Burg	email@texel.nl
Municipality Vlieland	PO Box 10	8899 ZG	Vlieland	info@vlieland.nl
Municipality Terschelling	PO Box 14	8880 AA	Terschelling-West	gemeente@terschelling.nl
Municipality Ameland	PO Box 22	9160 AA	Hollum	info@ameland.nl
Municipality Schiermonnikoog	PO Box 20	9166 ZP	Schiermonnikoog	postbus20@schiermonnikoog.nl
Municipality Delfzijl	PO Box 20000	9930 PA	Delfzijl	gemeente@delfzijl.nl
Municipality Reiderland	PO Box 3	9686 ZG	Beerta	info@reiderland.nl
Province of Groningen	PO Box 610	9700 AP	Groningen	info@provinciegroningen.nl
Province of Fryslân	PO Box 20120	8900 HM	Leeuwarden	info@fryslan.nl
Province of Noord-Holland	PO Box 123	2000 MD	Harlem	post@noord-holland.nl

Organization	Address	Postal code	City	E-mail
It Fryske Gea	PO Box 3	9244 ZN	Beetsterzwaag	info@fryskegea.nl
Het Groninger Landschap	Rijksstraatweg 333	9752 CG	Haren	kantoor@groningerlandschap.nl
Landschap Noord-Holland	PO Box 257	1900 AG	Castricium	info@landschapnoordholland.nl
Staatsbosbeheer Regio Noord	PO Box 333	9700 AH	Groningen	noord@staatsbosbeheer.nl
Staatsbosbeheer Regio West	PO Box 58174	1040 HD	Amsterdam	west@staatsbosbeheer.nl
Ecomare, centrum voor wadden en Noordzee	Ruijslaan 92	1796 AZ	De Koog - Texel	infobalie@ecomare.nl
Natuurcentrum Ameland	PO Box 60	9163 ZM	Nes-Ameland	
Bezoekerscentrum Schiermonnikoog	PO Box 32	9166 ZP	Schiermonnikoog	schiermonnikoog@nationaalpark.nl
Natuurmuseum Terschelling	PO Box 25	8880 AA	Terschelling-West	
Informatiecentrum De Noordwester	Dorpstraat 150	8899 AN	Vlieland	info@denoordwester.nl
Waddencentrum Pieterburen	Hoofdstraat 83	9968 AB	Pieterburen	pieterburen@groningerlandschap.nl
Dollard Bezoekerscentrum Reidehoeve	Dallingeweerster-weg 30	9947 TB	Termunten	kantoor@groningerlandschap.nl
Zeehondencrèche Lenie 't Hart	Hoofdstraat 94a	9968 AG	Pieterburen	info@zeehondencreche.nl
Staatsbosbeheer district Texel	Molenstraat 83	1791 DK	Den Burg	west@staatsbosbeheer.nl

Germany

Niedersachsen

Public Relations Official of	Address	Postal code	City	E-mail
Landkreis Aurich	Fischteichweg 7-13	D-26603	Aurich	eberhard.giese@landkreis-aurich.de
Landkreis Wittmund	Postfach 13 55	D-26400	Wittmund	reiner.janssen@lk.wittmund.de
Landkreis Leer	Friesenstr. 46	D-26789	Leer	georg.kloppenburg@lkleer.de
Landkreis Wesermarsch	Postfach 13 52	D-26913	Brake	landkreis-wesermarsch@lkbra.de
Landkreis Friesland	Lindenallee 1	D-26441	Jever	i.logemann@friesland.de
Landkreis Cuxhaven	Postfach 328	D-27453	Cuxhaven	67@landkreis-cuxhaven.de
Stadt Wilhelmshaven	Postfach 1140	D-26380	Wilhelmshaven	hilke.gnadt@stadt.wilhelmshaven.de
Stadt Cuxhaven	Postfach 680	D-27456	Cuxhaven	Udo.Jacob@cuxhaven.de
Stadt Emden	Frickensteinplatz 2	D-26721	Emden	wegmann@emden.de
Nationalpark-Häuser Nationalpark-Zentren	**Address**	**Postal code**	**City**	**E-mail**
Nationalpark-Haus Baltrum	Haus Nr. 177	D-26579	Baltrum	nlpe.baltrum@gmx.de
Nationalpark-Haus Carolinensiel	Pumphusen 3	D-26409	Wittmund-Carolinensiel	nationalparkh.carolinensiel@t-online.de
Nationalpark-Haus Dangast	Zum Jadebusen 179	D-26316	Varel-Dangast	nph-dangast@web.de
Nationalpark-Haus Dornumersiel	Oll Deep 7	D-26553	Dornumersiel	post@nordseehaus-dornumersiel.de
Nationalpark-Haus Fedderwardersiel	Am Hafen 4	D-26969	Butjadingen	nlph.museum.fed-siel@nwn.de
Nationalpark-Haus Greetsiel	Schatthauser Weg 6	D-26736	Krummhörn-Greetsiel	kontakt@nationalparkhaus-greetsiel.info
Nationalpark-Haus Juist	Carl-Stegmann-Str. 5	D-26571	Juist	NLPH.Juist@t-online.de
Nationalpark-Haus Land Wursten	Am Kutterhafen 1	D-27632	Dorum	Nationalpark-Haus_Land_Wursten@t-online.de
Nationalpark-Haus Norddeich	Dörper Weg 22	D-26506	Norden	amarliani@seehundstation-norddeich.de
Nationalpark-Haus Norderney	Am Hafen 1	D-26548	Norderney	nph.norderney@web.de
Nationalpark-Haus Wangerooge	Friedrich-August-Str. 18	D-26486	Wangerooge	nationalparkhaus.wangerooge@t-online.de
Nationalpark-Schiff "Feuerschiff Borkumriff"	Am Nordufer	D-26757	Borkum	fsbr@gmx.de
Nationalpark-Zentrum Cuxhaven	Hans-Claußen-Str. 19	D-27476	Cuxhaven	info@nationalpark-wattenmeer-cuxhaven.de
Nationalpark-Zentrum Wilhelmshaven	Südstrand 110 B	D-26382	Wilhelmshaven	info@wattenmeerhaus.de
Umweltzentrum Wittbülten Spiekeroog	Hellerpad 2	D-26474	Spiekeroog	info@wittbuelten.de
Nordseehaus Wangerland	Kirchstraße 9	D-26434	Wangerland-Minsen	nordseehaus@wangerland.de

Schleswig-Holstein

Organisation	Address	Postal code	City	E-mail
NationalparkZentrum Multimar Wattforum	Robbenberg 1	D-25832	Tönning	info@multimar-wattforum.de
Kreis Dithmarschen	Stettiner Straße 30	D-25746	Heide	erk.ulich@dithmarschen.de
Kreis Nordfriesland	Markstraße 6	D-25813	Husum	info@nordfriesland.de
Naturschutzgesellschaft Schutzstation Wattenmeer e.V	Grafenstraße 23	D-24768	Rendsburg	geschäftsstelle@schutzstation-wattenmeer.de
NSV Südtondern e.V	Kreuzweg 1	D-25899	Dagebüll	wp-a@gmx.de
Öömrang Ferian	Strunwai 31	D-25946	Norddorf	naturzentrumnorddorf@gmx.de
Naturschutzverein Mittleres Nordfriesland	Schobüller Str. 61	D-25813	Husum	uwe.g.g.koch@web.de
Wiedingharder Naturschutzverein	Wiedingharder Neuer Zoog 6	D-25924	Klanxbüll	bboysen@t-online.de
Verein Jordsand	Haus der Natur	D-22926	Ahrensburg	info@jordsand.de
Naturschutzbund Schleswig-Holstein	Färberstraße 51	D-24534	Neumünster	Info@NABU-SH.de
Söl'ring Foriining	Am Kliff 19a	D-25980	Keitum/Sylt	soelring-foriining@t-online.de
Naturschutzgemeinschaft Sylt e.V.	M.-T.-Buchholz-Stich 10a	D-25996	Wenningstedt/Braderup	naturschutz-sylt@t-online.de
WWF-Wattenmeerstation Husum	Hafenstraße 3	D-25813	Husum	roesner@wwf.de
Seehundstation Friedrichskoog	An der Seeschleuse 4	D-25718	Friedrichskoog	Tanja.Rosenberger@seehundstation-friedrichskoog.de
Biosphärenregion Halligen	Amt Pellworm	D-25849	Pellworm	info@biosphaerenregion-halligen.de
Insel- und Halligkonferenz	Mühlenweg 10	D-25938	Midlum/ Föhr	info@inselundhalligkonferenz.de
Nordsee-Tourismus-Service GmbH	Zingel 5	D-25813	Husum	info@nordseetourismus.de

8.d Official Web addresses

www.waddensea-secretariat.org

The Netherlands

www.waddenzee.nl

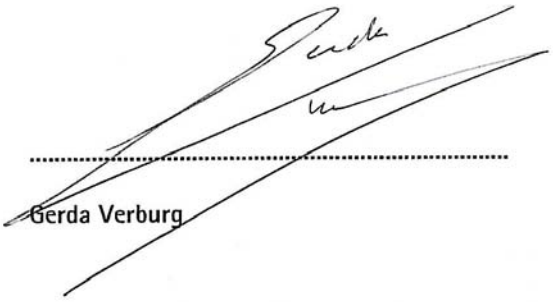
Germany

www.wattenmeer-nationalpark.de with links to the two Wadden Sea National Parks

9. SIGNATURES

FOR THE GOVERNMENT OF THE KINGDOM OF THE NETHERLANDS:

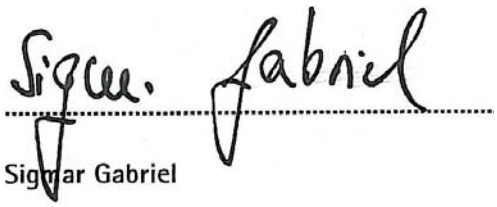
Minister of Agriculture, Nature and Food Quality



Gerda Verburg

FOR THE THE GOVERNMENT OF THE FEDERAL REPUBLIC OF GERMANY:

Minister for the Environment, Nature Conservation and Nuclear Safety



Sigmar Gabriel

Prime Minister of Niedersachsen

Christian Wulff

Prime Minister of Schleswig-Holstein

Peter Harry Carstensen

Tidal flats Schleswig-Holstein (Photo: Martin Stock).

Annex 01: The Outstanding Universal Value of the „Wadden Sea": A Geological Perspective

Prof. Dr. B.W. Flemming, Senckenberg Research Institute
Dr. A.P. Oost, National Institute of Coastal and Marine Management

Expert opinion for the Submission of the Dutch-German Wadden Sea for inclusion in the World Heritage List

1. Criterion vii: "contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance"

The oldest written record in which reference is made to the Wadden Sea dates back to the 1st Century AD when the Roman historian, Pliny the Elder, after personally visiting the southern North Sea coast in the year 47 AD, described it in his epochal work "Naturalis historia" as an "immeasurable expanse" which is inundated by the sea with forceful currents twice a day and of which it was uncertain whether it formed part of the land or the sea.

The manner in which Pliny describes his experience vividly expresses the fascination and awe which this strange and unique landscape aroused in an uninitiated observer. Is there a better way of expressing the outstanding universal character of a natural environment? The fascination and awe of this environment has persisted for thousands of years now, and it will continue to do so as we ponder the changes which the predicted acceleration in sea-level rise in the course of the next century will impose on it.

The fascination lies in the serene beauty and deceptive peacefulness of the continually changing landscape in the course of a mild and calm summer's day, when people walk the intertidal flats, making their way to the barrier islands between two high waters. Awesome, indeed, is the experience of a severe winter storm which suddenly and vehemently transforms these placid waters into a turmoil of howling winds, breaking waves and surging water levels which threaten

property and life. The written history of the region over the last millennium is full of pitiful records of such destructive inundations. Even as recently as 1953 in the Netherlands and 1962 in Germany, severe storm surges resulted in the loss of many lives, reminding us that - in nature - beauty and hazard often are but two sides of the same coin. The Wadden Sea is rightly being nick-named: "the flat wilderness". It is constantly changing and developing during every tide, and with every storm surge forming a bewildering multitude of unexpected forms of channels, marshes and tidal flats.

To consider this remarkable area as being beautiful is, as always, a judgement in the eye of the beholder. But we, the authors, are, after all these years, still fascinated and smitten by this overwhelming and unique landscape.

2. Criterion viii: "be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of land forms, or significant geomorphic or physiographic features"

a) Morphometry: geography and hydrography

The Wadden Sea is located along the continental coastline of the southern and south-eastern North Sea, stretching for about 500 km between Den Helder in the Netherlands (≈ 52°54'N/04°52'E) and Ho Bugt in Denmark (≈ 53°36'N/08°17'E) (Fig. 2). The nomination for the World Heritage List, in this case, restricts itself to the Dutch and German sectors of the Wadden Sea, where special protection statuses have been implemented in the form of National Parks (Germany) or Nature Conservation Areas (The Netherlands).

The area of the Wadden Sea as a whole, i.e. the combination of tidal flats, tidal channels and barrier islands, amounts to 9,281 km^2. Of this, 2970 km^2 or 32% are located in the Dutch sector and 5215 km^2 or 56% in the German sector (CWSS 1991; QSR 1993). Together, the Dutch and German sectors of the Wadden Sea thus occupy 88% of the total area. The tides are semidiurnal, the tidal range increasing from 1.4 m in the west (lower mesotidal) to around 4.0 m (lower macrotidal) in the inner German Bight, and back to 2.0 m (upper mesotidal) at the border between Germany and Denmark (and decreasing to 1.5 m near Skallingen). Maximum tidal current velocities in the channels typically reach about 1.5 ms^{-1} at spring tide. Although tidal action dominates the morphologic evolution, wind stresses and waves are important additional driving forces.

b) Morphology: a global perspective

The Wadden Sea (German and Dutch sectors) is an outstanding example of the on-going coastal and marine processes in the development of tidal flat deposits, which has led to the formation of the largest temperate zone tidal flat system in the World. According to the Ramsar Convention, the Wadden Sea falls into the wetlands category of estuaries, mangroves and tidal flats. Due to its sheer size, the Wadden Sea tidal flats morphologically and ecologically qualify as a wetland of major value. Searching through the lists of wetlands and considered wetlands (Thorsell et al., 1997, and the list of UNESCO World Heritage) shows that only few areas of the World Heritage list consist (partly) of tidal flats. The Wadden Sea is unique in that it consists entirely of a temperate-climate, sandy-muddy tidal system with only minor river influences fringing the flat and low-lying coastal North Sea Plain of the German Bight. Most of the tidal flat systems on the World heritage lists (both admitted and nominated) are closely related to rivers and their deltas, which, from a morphological and geological point of view, differ strongly from the Wadden Sea situation (e.g. Kakadu National Park in Australia and Sundarbans mangrove forest in Bangladesh), or are quite mountainous (e.g. Gros Morne National Park in Canada). The only tidal flats system, which is to some extent comparable, is the Banc d'Arguin National Park in Mauritania. This, however, is tropical-subtropical in character.

In principle, intertidal flats and barrier systems can be found worldwide along the shores of most continents and at latitudes from the tropics to the arctic ocean (e.g. Flemming 2002a, 2003). The preconditions are a low-gradient coastal plain and a sufficiently large supply of sediment to at least compensate the rate of sea-level rise. It is sufficient that these conditions existed at some stage during the past 8,000 years or so in order to initiate the formation of such coastal systems. Their survival to this day was then simply a function of the overall sediment budget in the course of continued sea-level rise, coupled with the slope angle of the hinterland.

At closer inspection, a number of unique types of tidal flat and barrier systems can be distinguished on the basis of biological criteria, although the basic physical form is identical in all

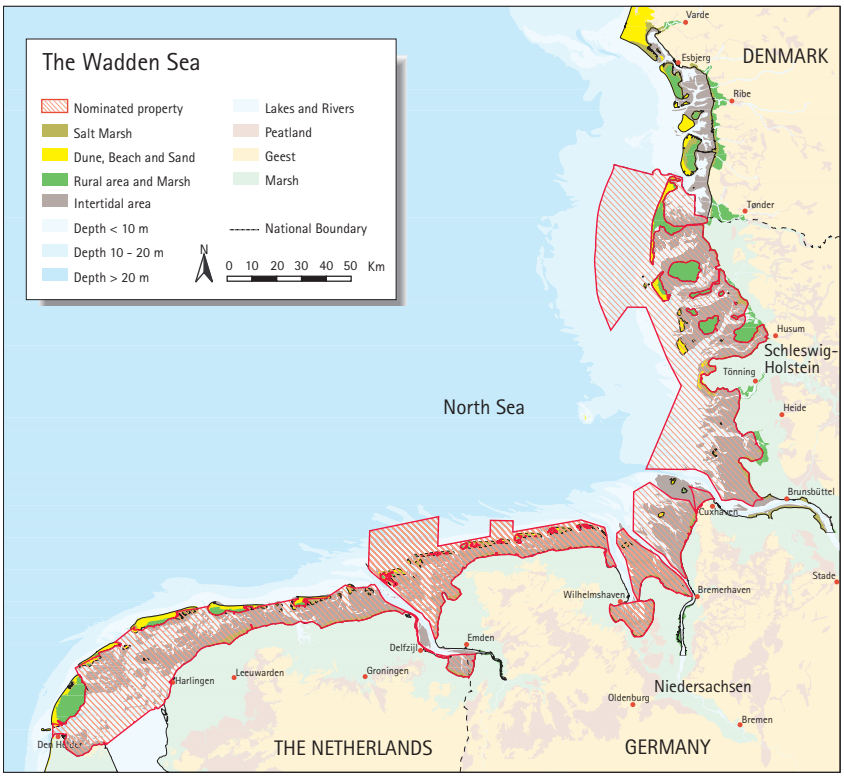


Figure A01.1:
Map of the nominated property.

cases. Thus, tidal flat and barrier systems in tropical and humid-subtropical climates are fringed by extensive mangrove forests (Augustinus 1995), whereas those in arid-subtropical, mediterranean, and higher-latitude climates are characterized by salt marshes (Chapman 1974). In addition, the benthic fauna varies with latitude, tropical and subtropical systems being dominated by a variety of burrowing crabs as indicator species which are progressively replaced by polychaetes and mussels towards higher latitudes (e.g. Reise 2000).

The Wadden Sea belongs to the salt-marsh category of tidal flat and barrier systems. It differs from other systems of this type in that it is the only extensive tidal flat and barrier-island depositional system in the World (it is also Europe's largest coastal tidal marsh and, as far as information is available, one of the biggest temperate climate inter-tidal flat area's with little river influence in the World, excluding mangrove areas). It is dominated by vast expanses of intertidal sediment flats which are exposed at low tide and display a progressively shoreward-fining grain-size gradient (Flemming & Bartholomä 1997). Due to this, and since it was described very early in the 20th century, it is a world-wide unique standard for reference and comparison with other tidal flats in the world. It commences with sand flats in the seaward sections, followed by mixed flats and finally mud flats along the mainland shore (e.g. Dijkema 1989). By contrast, the tidal flats of similar systems in other parts of the world are almost entirely occupied by eel grass meadows (e.g. the Ria Formosa in southern Portugal) or cord-grass marshes (e.g. the east coast of the U.S.A.). This fundamental difference in outward appearance produced by natural vegetation is due to a high supply of fine-grained sediments in the latter cases which has enabled the grass meadows and marshes to encroach entire sand flats by the capture and accretion of mud. Insufficient mud deposition has evidently prevented such basin-wide encroachments by sea grasses or pioneer plants in the case of the Wadden Sea, thereby defining the unique character of its landscape of mainly barren shoals divided by an intricate fractal channel pattern. And unique it is indeed: the Wadden Sea is mentioned in many international textbooks as the example, par excellence, of extensive meso- to macrotidal flats (Zenkovich, 1967; Cronin, 1975; Machatschek, 1973; Reineck & Singh, 1980; Reading, 1981; Schwarz, 1982; Allen, 1984; Stanley, 1989; Eisma, 1998; Reise, 2001).

c) Morphology: the unique details

The integrity of the depositional system composed of a hierarchy of hydro-morphological units is expressed in a coherent lateral sequence. Thus, the basic units of the West and East Frisian Wadden Sea are a series of contiguous tidal basins which are separated from each other by tidal watersheds (Flemming & Davis 1994; Oost & de Boer 1994). These, in turn, are subdivided into a number of characteristic erosional and depositional features such as barrier islands, inlets, ebb-deltas, tidal drainage networks comprising a series of channel hierarchies (gullies), sand flats, mixed flats, mudflats, and salt marshes.

In addition to these structural elements of the barrier islands and tidal basins, the shorefaces of the West and East Frisian barrier island systems consist of several morphodynamic units which, from a geological point of view, are integral parts of the system as a whole: integrity of the interaction is still intact. Thus, the lower shoreface below about 10-12 m of water depth is structured into a series of NW-striking ridges and valleys, so-called shore-face connected ridges, which have spacings of several kilometres and heights of up to 6 m. Such ridge systems have also been reported from other parts of the world, both from barred and non-barred tidal coasts.

The morphology of the upper shorefaces, by contrast, can be subdivided into shore-parallel sand bars typical of many surf zones worldwide, and NE-striking so-called sawtooth bars which occur in water depths between 3 m and 6 m and which have spacings of around 450 m and heights of up to 2 m (Fig. 10.2). Flemming & Davis (1994) have reinterpreted this ridge and swale topography as representing incised rip-current channels associated with nearshore wave/current generated resonance phenomena. These features appear to be unique to the Dutch and German barrier-island coast.

The macrotidal part of the Wadden Sea lining the inner German Bight lacks barrier islands and hence also ebb-deltas, but otherwise displays similar features as the back-barrier tidal basins, including a number of tidal watersheds. The reason for the absence of barrier islands is the large volume of water which has to be moved into and out of the coastal zone twice a day by the falling and rising tide. This leaves no room for barrier islands, although small ephemeral sand-bank islands may occur from time to time in odd places around mean sea level (Ehlers 1988). In addition, extensive shell beds line many upper sand flats due to the stronger action of storm waves which are less effective in the more protected tidal basins in the rear of the barrier islands.

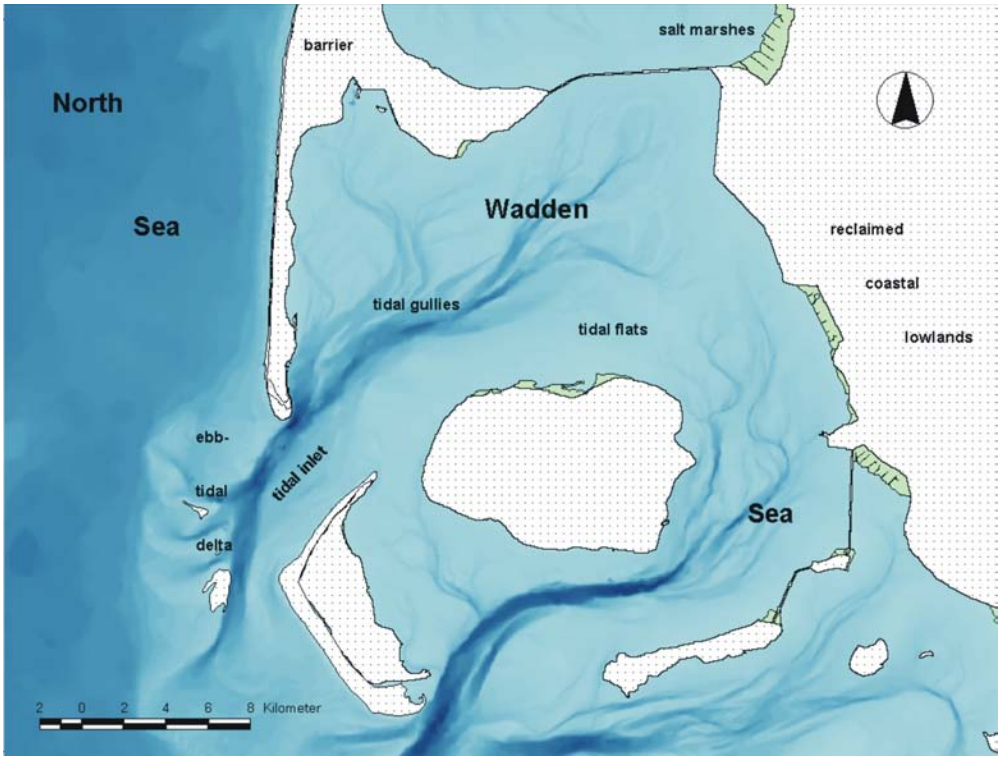


Figure A01.2: A tidal basin in Schleswig-Holstein (Sylt-Amrum-Föhr) with typical hydro-morphological elements of the Wadden Sea coast (Jacobus Hofstede)

Figure A01.3 :Typical saw-tooth bar system in front of a barrier island of the East Frisian Wadden Sea.

Locally, unique sedimentary features are present such as naturally open barrier coasts consisting of dunes intersected by small wash-overs (e.g. Ameland). This is unique to NW-Europe.

d) Morphodynamics

As stated above, geological processes are still very active in the development of landforms and continuously lead to the renewal and/or destruction of the landscape by building and/or destroying a variety of geomorphic features. The Wadden Sea's outstanding universal value is mainly due to the strong hydraulic and aeolian dynamics leading to prominent morphological changes on a variety of spatial and temporal scales, from whole groups of inlet systems, influencing each other over many centuries, down to the shifting of a ripple in the order of minutes. Of course, the natural forces not only lead to an autonomous dynamics, but also react to human interventions in the form of land reclamation and dike construction. Morphodynamic adjustments are possible due to the fact that the Wadden Sea system can still react in a natural way to these influences because it is still able to evolve freely in the larger part of the tidal system. On each scale destructive exogenic processes alternate with constructive ones.

Closely interwoven with these dynamics are human activities, man having sought to improve the quality of lifein and around the area for hundreds and even thousands of years. Fisheries, tourism, transport, agriculture and even industry depend on the tides and the changes they bring about in the system, from day to day and from year to year.

e) Morphogenetics

Although we would not press this as a major criterion, the Wadden Sea in its way also represents, in quite a dramatic way, two natural examples of coastal shelf development under conditions of the Holocene sea-level rise. The modern Wadden Sea evolved in the course of coastal evolution since about 8,000 years BP in the wake of the postglacial sea-level rise. Next to sea-level rise itself, a progressively growing tidal range resulting from the increasing water depth in the North Sea basin, the regional storm climate, the sediment budget and, last but not least, an increasing human impact have played prominent roles in its evolution in the course of the last millennium (e.g. Oost & de Boer; Flemming & Davis 1994). However, on the whole, the Wadden Sea has kept its morphological integrity, showing a broad suite of geomorphological features.

As a result of sea-level rise and a mostly deficient sediment budget, the coast retreats in a landward direction while accreting vertically. Today, we distinguish between transgressive and aggradational tidal flat systems in the Dutch and German sectors of the Wadden Sea (cf. Vos & van Kesteren 2000; Flemming 2002b). The lower mesotidal West Frisian (Dutch) and the upper mesotidal East Frisian (German) barrier island systems are transgressive systems. Since not enough sediment is imported from external sources, the systems compensate sea-level rise by moving material from their upper shorefaces to the back-barrier basins. As a consequence, the islands migrate shorewards across their own back-barrier flats in a process also know as roll-over. The lower macrotidal, non-barred tidal flats of the inner German Bight and southern section of the North Frisian tidal flats, which occasionally display ephemeral supratidal shoals, are essentially aggradational systems, sediment influx from external sources in this case compensating sea-level rise. The northern, barred section up to the border of Denmark is once again transgressive. Form, sequence and scale of these subdivisions are unique to the Wadden Sea.

f) Morphochronology: relevance for the geological inventory

The long-term depositional history has led to the formation of a series of sedimentary deposits which have recorded the development of the Wadden Sea and climate in great detail. Such datable sediments (e.g. Vlieter deposits) and landforms (e.g. SW Texel and the German tidal marsh deposits) can be considered a universally important archive of the Holocene history of sea-level rise, climate, and depositional response.

As stated above, the Wadden Sea represents an outstanding example representing the Holocene development of a sandy coast under conditions of a rising sea level, and, as such, attracted the interest of scientists at an early stage of scientific endeavour. The Wadden Sea is one of the earliest and best studied depositional systems in the world, first scientific investigations dating back to the early years of the last century. Over the years, Dutch, German and Danish geoscientists in particular have established large archives of documentary evidence for tidal processes, stratigraphy, sedimentary structures and sediment distribution patterns in the form of numerous publications, maps, drawings, photographs, slides, seismic profiles, lacquer peels, resin casts, and core logs (see overview of the most important institutes). Together they form an invaluable and unique inventory of the geological character of the Wadden Sea and its genesis, which is unparalleled in the world. Such archives are accessible at a number of marine research stations lining the Wadden Sea coast. In this context, the geological/geomorphological criterion (viii) favouring a nomination of the Wadden Sea for the World Heritage List not only relates to the theme "coastal systems", but has direct links to other themes such as "stratigraphic sites" and "fossil sites". As indicated above, the stratigraphic and fossil record of the Wadden Sea form part of the overall geological inventory accumulated in the archives of numerous coastal research institutions.

f) Educational value

As in the case of other natural environments, a generally underrated value of the Wadden Sea is its important role in coastal education and research. Wadden Sea research has become synonymous with the geological principle that "the present is the key to the past" (Lyell 1830-33; Geikie 1905). There are few marine areas in the world which are so easily and directly accessible for a hands-on education of scholars and students in the natural sciences. Every year, dozens of school and university classes visit the Wadden Sea for educational purposes, often under the guidance of one of the marine research stations located along the coast. Besides coming from Germany and The Netherlands, regular excursion groups come from afar as Austria and Switzerland. In addition, professional courses are offered regularly to geoscientists employed in governmental, semi-governmental and industrial institutions.

Country	Location	Institute	Data
Germany	Wilhelmshaven	Senckenberg Institute	Cores, laquer-peels, grain-size data, side-scan sonar images, seismic profiles, geochemical data, biological data, hydrodynamic data
Germany	List on Sylt	Alfred-Wegener-Institute	Biological data, cores, sediment data
Germany	Büsum	Forschungs- und Technologie-zentrum Westküste, University of Kiel	Cores, grain-size data, laquer peels, hydrodynamic data, biological data
Germany	Norderney	NLWK-Forschungsstelle Küste	Historical chart reconstructions, morphological data, hydrodynamic data, biological data
Denmark	Copenhagen	Institute of Geography, University of Copenhagen	Grain-size data, cores, datings,geochemical data
The Netherlands	Den Hoorn	Neth. Inst. For Sea Research	Grain-size data, cores, datings, geochemical data
The Netherlands	Utrecht	Fac. Of Geosciences, Univ.of Utrecht	Laquer peels, reconstructions, cores, sieve data, hydraulic data
The Netherlands	Delft	Technical University Delft	Modelling results
The Netherlands	Utrecht	TNO-Bouw en Ondergrond	Cores, datings, seismic profiles

Conclusions

The "outstanding universal value" of the Wadden Sea can be summarized as follows:

1) It is a landscape of Outstanding Beauty. It has a long historical record of intensive interactions and responses to human settlement and intervention;

2) It is the largest sandy-muddy tidal flat and salt marsh area protected by sandy barrier systems occurring in the temperate zone of the world;

3) Its shoreface shoreline is characterized by morphological features which are at least in part unique to this area: despite human interventions, it has maintained its unique character and morphological integrity;

4) It forms an important natural educational and research laboratory for scholars, students and scientists by illustrating the geological principle that "the present is the key to the past", with the oldest written record dating back almost 2000 years. Two examples: it forms a comprehensive archive of Holocene coastal evolution, climate change, and depositional responses which is unparalleled in the world;

5) It can be directly linked to other themes of the World Heritage List such as "stratigraphic sites" and "fossil sites".

4. References

Allen, J.R.L.., 1984. Sedimentary structures, their character and physical basis. Developments in Sedimentology, no. 30, Elsevier, Amsterdam.

Augustinus, P.G.E.F., 1995. Geomorphology and sedimentology of mangroves. In: Perillo, G.M.E. (ed.), Geomorphology and sedimentology of estuaries. Elsevier Science, Amsterdam, p. 333-357.

Chapman, V.J., 1974. Salt marshes and salt deserts of the world. Cramer, Lehre.

Cronin, L.E., 1975. Estuarine Research, Vol I & II. Academic Press, Inc., New York.

CWSS, 1991. The Wadden Sea. Status and developments in an international perspective. Common Wadden Sea Secretariat, Wilhelmshaven. Geffken Druck, Bremen.

Dijkema, K.S., 1989. Habitats of the Netherlands, German and Danish Wadden Sea. Research Institute for Nature Management, Texel & Veth Foundation, Leiden. J.G. van Beek, Leiden.

Ehlers, J., 1988. Morphodynamics of the Wadden Sea. Balkema, Rotterdam.

Eisma, D., 1998. Intertidal deposits; river mouths, tidal flats and coastal lagoons. CRC Press, Boca Raton, 525 pp.

Flemming, B.W., 2002a. Geographic distribution of muddy coasts. In: Healy, T., Wang, Y & Healy, J.-A. (Eds), Muddy coasts of the world: processes, deposits and function. Elsevier Science, Amsterdam, pp. 99-201.

Flemming, B.W., 2002b. Effects of climate and human interferventions on the evolution of the Wadden Sea depositional system (southern North Sea). In: Wefer, G., Berger, W., Behre, K.-E. & Jansen, E. (eds), Climate Development and history of the North Atlantic realm. Springer, Berlin, p. 399-413.

Flemming, B.W., 2003. Tidal flats. In: Middleton, G.V. (ed.), Encyclopedia of sediments and sedimentary rocks. Kluwer, Dordrecht, p. 734-737.

Flemming, B.W. & Bartholomä, A., 1997. Response of the Wadden Sea to a rising sea level: a predictive empirical model. German J. Hydrogr. 49: 343-353.

Flemming, B.W. & Davis, R.A., Jr., 1994. Holocene evolution, morphodynamics and sedimentology of the Spiekeroog barrier island system (southern North Sea). Senckenbergiana maritima 25: 117-155.

Geikie, A. Sir, 1905. The Founders of Geology. Macmillan & Co., New York.

Lyell, C., 1830-33. Principles of Geology. 3 Volumes. Murray, London.

Machatschek, G., 1973. Geomorphologie, 10th Ed. B.G. Teubner, Stuttgart.

Oost, A.P. & de Boer, P.L., 1994. Sedimentology and development of barrier islands, ebb-tidal deltas, inlets and backbarrier areas of the Dutch Wadden Sea. Senckenbergiana maritima 25: 65-115.

QSR, 1993. Quality Status Report of the North Sea (QSR). Subregion 10. The Wadden Sea. Common Wadden Sea Secretariat, Wilhelmshaven. Geffken Druck, Bremen.

Reading, H.G., 1981. Sedimentary Environments and Facies, Blackwell Sc. Publ., Oxford.

Reise, K., (Ed.) 2000. Ecological Comparisons of Sedimentary Shores. Ecological Studies 151. Springer-Verlag, Berlin.

Reineck, H.E. & Singh, I.B., 1980. Depositional sedimentary environments, Springer-Verlag, Berlin.

Schwarz, M.L., 1982. The Encyclopedia of beaches and coastal environments. Van Nordstrand Reinhold Company Inc., New York.

Stanley, S.M., 1989. Earth and Life through Time, 2nd Ed., W.H. Freeman & Company, New York.

Vos, P.C. & van Kesteren, W., 2000. The long-term evolution of intertidal mudflats in the northern Netherlands during the Holocene: natural and anthropogenic processes. Continental Shelf Research 20: 1687-1710.

Zenkovich, V.P., 1967. Processes of Coastal Development, Oliver & Boyd, Edinburgh (translated from the Russian).

Saltmarsh on the island of Juist (Photo: Norbert Hecker).

Annex 02: The Outstanding Universal Value of the „Wadden Sea": An Ecological Perspective

Baptist, M.J., Dankers, N. and Smit, C. 2007. Wageningen University and Research Centre.

Expert opinion for the Submission of the Dutch-German Wadden Sea for inclusion in the World Heritage List

1. Summary

This report describes the Outstanding Unique Values of the Wadden Sea from an ecological perspective, that is, according to criteria IX and X for the nomination of World Heritage Sites, as defined by the IUCN World Commission on Protected Areas.

The Wadden Sea is an outstanding example of the Holocene development of a sandy coast under conditions of rising sea level and is unique in that it is the largest extensive tidal flat and barrier island depositional system in the World. Its geological and geomorphological features are closely entwined with biophysical processes (biogeomorphology). The biogeomorphological interactions are notably strong and unique on all scales.

The rich and diverse habitats are of outstanding international importance as an essential habitat for of migratory water birds using the East Atlantic Flyway and other migration routes between South Africa, Northeast Canada, and northern Siberia. It is one of the few shallow seas in the Northern Hemisphere with a relatively high production of fish and serves as a nursery area and an essential staging area for species migrating between freshwater and saltwater for spawning and feeding.

The proposed property encompasses all the biophysical and ecosystem processes that characterise a natural and sustainable Wadden Sea. The standards of protection, management and monitoring ensure that the natural Wadden ecosystem, with all its component parts, will continue to evolve naturally and to sustain human

uses for the foreseeable future. Man's use of the natural resources in a sustainable way including traditional resource use is a key to guarantee its integrity for generations to come.

2. Introduction

Since the Esbjerg Wadden Sea Conference in 1991, the nomination of the Wadden Sea as World Heritage Site is being prepared. In recent years progress is high; since 2005 The Netherlands and Germany are working hard on the preparation of a nomination dossier.

The ministry of Agriculture, Nature and Food Quality is co-ordinating the nomination on behalf of the Dutch government. They have requested IMARES, location Texel, to report the Outstanding Universal Values of the Wadden Sea with regard to criteria IX and X. These criteria describe the most important and unique on-going ecological processes and the biodiversity in the nominated site. In addition, the natural integrity of the site should be assessed, the protection and management status should be described and a comparative analysis of other similar sites around the world should be made. This knowledge subsequently feeds into Chapter 3 of the nomination dossier and the complete text of this report will be incorporated as an appendix to the dossier.

This report consists of two chapters that refer to the criteria IX and X as defined by the IUCN World Commission on Protected Areas, and a list of references.

3. Criterion ix "be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals"

Physical processes shaping shallow coastal zones can be found anywhere in the world. The Wadden Sea, however, is of a special kind. It is the only non-tropical extensive tidal flat and barrier-island depositional system in the World (see criterion viii) (Wolff, 1983). Very characteristic are the non-fixed, and therefore 'walking islands' or considerable parts of islands. Of a special kind are the biogenic structures such as reefs of oysters, mussels or tube-building worms that affect the morphology as 'ecosystem engineers'. Its sheer size gives rise to a multitude of biophysical and ecological processes that cannot be found within one system anywhere else. The Wadden Sea is characterized by a *complete system of gullies and flats*, i.e. an outer delta, a tidal inlet and a basin with ebb-and flood gullies that end in very small '*prielen*'. The completeness of this system, which is found in a fractal manner, is extraordinary; see Figures. A02.1, A02.2 and A02.3. The tidal-channel systems can be regarded as 'statistical self-similar fractal'networks and the similarity of the channel systems points to a self-organising nature (Cleveringa & Oost, 1999). On smaller scales, fractal patterns are also found in the muddy deposits. Moreover, the spatial distribution of intertidal benthic communities shows fractal patterns as well. Intertidal mussel beds in the Wadden Sea, for example, show a spatial self-organisation (Van de Koppel et al., 2005). Interestingly, the origin of fractal patterns in ecosystems can have seven different explanations (Halley et al., 2004). For benthic communities two possible explanations are likely: The first is that a fractal distribution of abiotic factors presents a template upon which organisms and communities operate. The second is that a fractal spatial pattern is a result of community self-organisation which is transformed in spatial structures under environmental influences (Azovsky et al. 2000). A final answer has not been given yet. It is known that complex spatial patterns affect ecosystem processes such as resource utilization, movement of organisms and redistribution of nutrients, and that they support more complex ecological communities (Turner, 1989; Levin, 1992). Research focusing on the linkages between scales, ecological processes and complexity is a central problem in biology. The Wadden Sea is a prime example.

An ecosystem can only function in an optimal state when all physical, chemical, geomorphological and biological processes can operate in an undisturbed and coherent manner and in a functional relationship. When a system is large enough and many parts are relatively undisturbed there is a big chance that this will be the case for the system as a whole. The Wadden Sea fulfills this criterion.

The Wadden Sea is a relatively young system that has developed because of sea-level rise in the past 6000 years (Beets & Van der Spek, 2000). It has a *variety of flat types*, ranging from coarse sand in the inlet, up to silt and mud along the inner margins and at the *tidal divide* behind the barrier islands. Some flats emerge only shortly, others only inundate during storm floods. In an interplay of physical, ecological and biological

Figure A02.1 (left): Pattern of gullies in the Eijerlandse inlet between Texel and Vlieland (scale 30x30 km).

Figure A02.2 (right): Pattern of 'prielen' on a tidal flat (scale 200 x 200 m) (Photo courtesy Martin de Jong, IMARES).

Figure A02.3: Pattern of very small ' prielen' on a tidal flat (scale 1x1 m) (Copyright Waddenvereniging).

processes specific structures or even landscape size forms develop. On the shore, where vegetation can grow, *coastal dunes* form in the more exposed, sandy parts and *saltmarshes* in the sheltered, muddy parts. In the tidal flat itself, extremely high densities of specific animal species influence the system in such a way that they form biogenic structures such as mussel beds, oyster and *Sabellaria* reefs. To our knowledge, such biogenic reefs in nontropical waters have not been listed before in World Heritage Nominations.

The whole range of these geomorphological and biological structures and communities occur in a functional relationship, making the Wadden Sea a 'complete' ecosystem. This means that functional relationships are found on all spatial and temporal scales in coherence with each other. Its completeness and size make the Wadden Sea an outstanding and unique non-tropical ecosystem. Furthermore, due to the estuarine influence of the Rhine (although through sluices) and Eems, Weser, Elbe, Eider and Varde Aa one finds density-driven currents, a turbidity maximum and a biological richness including migratory fish and brackish species.

Physical drivers, such as tides, wind, currents, waves, and biological processes, such as competition for resources, occurring in a large area have resulted in the richness of geomorphological and biogenic structures found. Due to the undisturbed presence of these processes, structures are not only conserved, but there are also rejuvenation cycles, creating new structures and breaking down old structures. Examples are the dunes and saltmarshes that can be found in all stages of succession, and structured mussel banks, which are formed by a combination of growth and food depletion from the overlying water (Van de Koppel et al., 2005).

As a shallow sea, the benthic-pelagic coupling is notably strong, and the primary and secondary production are high. This production forms a foundation to the intricate food web that ultimately results in an important nursery area for fish, a foraging and resting habitat for seals, and a foraging habitat for waders, which will be discussed later in more detail. These functions of the Wadden Sea, and specifically its importance as a nursery area, were the main arguments in the 1970s not to embank this system, and it still serves as a prime example of the change in attitude in large scale conservation of ecosystems on landscape scale. In the US at that time the emphasis was laid on the function of saltmarshes in production and export of organic matter and nutrients to the coastal ecosystem. In the case of the Wadden Sea the emphasis was more on its specific value in combination with the services to surrounding ecosystems. The Wadden Sea has an intrinsic relationship with the North Sea. The North Sea is one of the few shallow and relatively

sheltered seas in the Northern Hemisphere with a relatively high production of fish. The combination of a large, shallow and highly productive sea combined with a system like the Wadden Sea is unique on a world scale (Wolff, 1983).

a) Primary and secondary production

One of the outstanding features of the Wadden Sea is that the in situ primary production is to a large extent the result of benthic production. In coastal zones in general, the phytoplankton production dominates, but the Wadden Sea is unique in its enormous surface area of emerging tidal flats that host high densities of microphytobenthos. The contribution of microphytobenthos to the primary production is about as high as the primary production by planktonic algae (Cadée & Hegeman, 1974a and b; Asmus et al., 1998). The gross primary production by microphytobenthos, which reaches values of over 1000 mgC m^{-2} d^{-1}, is the highest in the world for locations north of 42° latitude (MacIntyre et al., 1996). Next to the in situ production there is a large net import of algae produced in the coastal regions of the North Sea. Because of the abundant supply of algae, the secondary production is large, as well. The sandy and muddy bottoms host a variety of macrozoobenthic herbivores, which can reach locally high densities. Not only phytoplankton, but also benthic diatoms are an important food source for filterfeeding bivalves. Suspended microphytobenthos may represent up to 50 % of the microalgae in the water column and thus of the food of filterfeeders (De Jonge, 1985).

b) Biogenic structures and biogeomorphology

Due to the shallowness of the area and the fuzzy boundaries between land and sea, there is a strong interaction between biota and geomorphological processes, i.e. biogeomorphology (Baptist, 2005; Stallins, 2006). The geomorphological influence on biota is in its most direct form the influence on habitats of flora and fauna. The Wadden Sea morphology and geomorphological processes therein define gradients between high and low, wet and dry and sedimentation and erosion. These gradients and the processes that cause them are determinative for gradients in grain size of the sediment, nutrient levels, organic matter levels and moisture. Plants and animals are tuned to specific conditions and will therefore be abundant in specific locations, i.e. there habitats. In the coarse grained and dynamic sediments a large abundance of specific polychaete worms (*Scolelepis squamata*) occurs with densities of up to 300 grams/m^2. In the more sheltered parts the flats are abundant with worms and cockles. Mussel beds are recovering after closure of fisheries, and in dense beds of shellfish, biomass may reach values of more than 50 kg per m^2. Conversely, the biological influence on geomorphological processes is the influence of biota to create, maintain or transform their own geomorphological surroundings. This is demonstrated by the influence of vegetation on the hydraulic resistance, erodibility and sedimentation, or by the influence of fauna on sediment characteristics through bioturbation and biostabilization.

The Wadden Sea forms an outstanding example of biogeomorphological interactions. Important in this respect is that the Wadden Sea has many examples in which the timescale for geomorphological changes coincides with the timescale for biological changes. This results in mutually interacting processes. Unlike other areas in the world, landscape processes are not dominated by geological timescales nor do biological processes dominate landscape features. This means that the constantly changing landscape requires adaptation of organisms and at the same time that organisms affect their environment as 'ecosystem engineers'. Excellent and broad scale examples of these biogeomorphological interactions can be found in the dunes, the tidal flats and the saltmarshes. Of particular interest are for example the intertidal mussel beds. These form a biogenic structure that has considerable influence on the morphology of the tidal flats; they stabilize the sediment, preventing it from erosion and actively accrete silt. The numerous macrobenthic species can have an opposite effect. Their constant reworking of the sediment (bioturbation) makes the bed more susceptible to erosion. Saltmarshes form another example in which the capturing of silt increases the bed level, which leads to changes in vegetation composition and subsequent changes in sedimentation rates.

The important ecosystem types in the Wadden Sea (ecotopes or habitats) are those which are formed and maintained by an interplay of physical and biological processes. This interplay is essentially an interaction of on-going geological processes in the development of landforms and on-going ecological and biological processes. This feature cannot be described under criterion viii or criterion ix separately.

Biogeomorphology in the Wadden Sea

Physical processes in the Wadden Sea and its estuaries, such as flow, tides and waves, are responsible for the mixing of the water column, the transport of sediment and the transport of nutrients and organisms. Sandy coasts with small tidal amplitude develop into a system of barrier-islands with intertidal flats between the islands and the mainland. The tidal currents together with wind and wave action are responsible for the maintenance of gullies and tidal flats. The Wadden Sea system is characterized by complete gully system. That means a tidal inlet, ebb and flood systems and main channels, which branch into small gullies and creeks in sandy or silty areas or salt marshes. Within the Wadden Sea system there is a diversity of tidal flats with sediment of different silt content and different exposure times.

Biological processes both respond to and affect pattern diversity, geomorphological processes and sediment characteristics. Typical structures of biogenic origin can develop on the tidal flats, such as oyster and mussel beds, reefs of tube building polychaetes, eelgrass fields, burrows and tubes of digging polychaetes or mats of microphytobenthos. Biogenic habitat transformations result (Reise, 2002). Reefs of suspension feeders increase bed roughness and actively filter suspended particles, accumulating these in the bed and leading to a raised and stabilized bed. Eelgrass meadows slow down flow, protect the bed from erosion and trap suspended particles, raising the bed. The reworking of the bed by infauna changes the sedimentary budget and composition, and making it more susceptible to erosion. Mats of microphytobenthos have a seasonal effect on bed height and silt content through excretion of polymeric substances gluing the bed particles together and thus making it more resistant to erosion. In quiet places under favourable conditions salt tolerant pioneer vegetation may develop on tidal flats. When the pioneer vegetation is succeeded by a vegetation of the next successional stage, the young, low-lying salt marsh will maintain itself by enhancing sedimentation. In a period with sea-level rise, the marsh will grow higher but if the tidal flat lags behind, cliff formation along the marsh occurs. Subsequently, the marsh will erode until new vegetation will develop on the bare gently sloping tidal flat.

All these biogeomorphological interactions can be found in and on the tidal flats of the Wadden Sea. The constantly changing conditions, the multitude of feedback systems and the very wide variety in scales make it a unique ecosystem.

Because the Wadden Sea contains many different types of islands, sheltered and exposed dunes and subsequent sheltered and exposed types of saltmarsh and green beaches there also is a great variety in vegetation types and communities. Many textbooks refer to the Wadden Sea as a strong example when describing different vegetation types. An excellent overview of vegetation types is found in Dijkema & Wolff (1983). Dijkema et al. (1984) investigated all saltmarshes along the European coasts and concluded that those bordering the Wadden Sea are of eminent importance because of their size and completeness.

Dense concentrations of animals, whether forming biogenic structures or not, may form specific communities. More than 125 years ago the community of an oyster reef in the Wadden Sea was described and the term '*BIOCOENOSIS*' was introduced (Möbius, 1877). This term is now widely used in the ecological literature, and the present day mussel beds and oyster reefs can still be regarded as prime examples.

Integrity and/or authenticity

The Wadden Sea has sufficient size to contain a functional coherence of ecosystem elements. Morphodynamic processes have relative freedom to occur. Biological processes depending on, and affecting geomorphology can be found on many scale levels, from seasonal microphytobenthos mats gluing the sediment together to saltmarshes raising the sediment level and growing with sea level rise. Anthropogenic influences are well regulated, a set of ecotargets is internationally agreed on (Esbjerg declaration) and monitored to safeguard the integrity. Rehabilitation measures are being carried out, for example on mussel beds. Up to the seventies mussel beds covered extensive parts of the tidal flats, filtering the water above and producing faecal pellets that sink to the bed. As a result, these beds capture fine sediments and prevent erosion. Due to over fishing these beds have almost disappeared, but rehabilitation measures seem to work out well (Dankers et al., 2003, 2004., De Vlas et al., 2005).

The present status of the system is well described by Essink et al. (2005) in the most recent Quality Status Report (QSR), and possible threats are given by Nordheim et al (1996) and Ssymanck & Dankers (1996).

Protection and management

The protection status of the Wadden Sea is sufficient to keep the system in its present state, but more conservation efforts are required in order to reach a favorable conservation status as required by the EU-Bird and Habitat directives. These

measures are laid down in many agreements and European and national legislation.

Comparative analysis

The Wadden Sea forms an outstanding example of biogeomorphological interactions on all scale levels. The features of shallow productive mud flats, strong benthic-pelagic coupling and interactions between biology and morphology can be found in other estuaries, but not on the scale and the completeness of the Wadden Sea. The closest resemblance has the Banc d'Arguin in Mauritania. Its total size is larger than the Wadden Sea (12,000 km^2), but half of it is terrestrial and it has much less intertidal area (540 km^2). Furthermore, it is located in an entirely different biogeographical region, it does not have barrier islands and has very sheltered regions. In fact, the comparative analysis in the nomination dossier of the Parc national du Banc d'Arguin does not even consider the Wadden Sea as a comparable area.

There is no similar area in northern latitudes to be found. The Ria Formosa is of a much smaller size, not containing similar dune and saltmarsh systems, while there also is a lack of very silty parts. The barrier systems of North/South Carolina and Georgia (US East coast) have similar geomorphological characteristics but are very different from an ecological point of view because the intertidal flats are covered with *Spartina*, while these in the Wadden Sea are bare or partly covered by sea grasses (*Zostera* sp.). The barrier systems of Louisiana can not be compared because they have such a small tidal range that the majority of the sandbanks are permanently covered by the sea.

4. Criterion x "contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation"

The Wadden Sea is extremely rich in environmental gradients and transitional zones, yielding many different (micro)habitats. This forms the basis for exceptional species diversity. The saltmarshes host about 2,300 species of flora and fauna. The marine and brackish areas count even 2,500 species. As a result of the many different microhabitats, there is a high degree of ecological specialization.

a) Fish

The shallow environment of the Wadden Sea is of vital importance to the reproduction of many fish species (Berghahn, 1987). The Dutch Wadden Sea is used by 13 species that are hatched in the North Sea and use the Wadden Sea as nursery area, the Marine Juvenile species. An additional 17 species are Estuarine Resident; they live here during their entire life cycle. Furthermore, there are 10 species that use the Wadden Sea seasonally in search for food, 9 species that migrate through the Wadden Sea, 2 freshwater species and in total 45 marine visitors have been caught since 1960 (Hovenkamp & Van der Veer, 1993). The Wadden Sea is, therefore, indispensable for a much wider area comprising large parts of the North Sea. Since there is an active exchange of fish between the North Sea and the Wadden Sea, population dynamics of North Sea fish species can drive ecological processes in the Wadden Sea. The Wadden Sea is important to migratory fish. It gives an open connection between large rivers, such as Eems & Elbe, and the North Sea. The following fish species are (or were in case of the sturgeon) found in the Wadden Sea and are listed on the IUCN Red List:

Species	Common name	IUCN Red List status
Acipenser sturio	Common sturgeon	CR A2d
Alosa alosa	Allis shad	DD
Alosa fallax	Twait shad	DD
Coregonus oxyrinchus	Houting	DD
Lampetra fluviatilis	River lamprey	LR/nt
Raja clavata	Thornback skate	LR/nt

Restoration of smooth salinity gradients in open connections with (small) rivers might improve conditions for these migratory species.

b) Marine mammals

On top of the benthic and pelagic food chain, marine mammals depend on the large productivity of the Wadden Sea. Four species are inhabitants of the Wadden Sea: Harbour seal (or Common seal), Grey seal, Harbour porpoise and Bottlenose dolphin.

Harbour seals in Europe belong to a distinct sub-species (*Phoca vitulina vitulina*) which is found mainly in UK, Icelandic, Norwegian and Wadden Sea waters. The international Wadden Sea holds approximately 20% of the world-population (some 20,000 individuals). Samples from seals in Northern Ireland, the west and east coasts of Scotland, the east coast of England, the Dutch and German Wadden Sea, the Kattegat/Skagerrak, Norway, the Baltic Sea and Iceland have been sub-

jected to genetic analysis. This analysis suggested that there are genetically distinct common seal populations in European waters (Goodman, 1998). There is probably very little movement of breeding animals between these populations.

A unique feature of the Wadden Sea Harbour seals is that they rely on the Wadden Sea tidal sandflats for resting. Their resting habitat disappears during high tide and therefore, their behaviour is completely adapted to these conditions. There's one other location where this is found, The Wash (UK), however an insignificant number of seals are situated here. All other Harbour seal habitats consist of rocky shores.

Grey seals (*Halichoerus grypus*) are found across the North Atlantic Ocean and in the Baltic Sea. There are three regional populations. One in the Northwestern Atlantic; in Canada, on Nova Scotia and the Gulf of StLawrence, one in the Northeastern Atlantic; Iceland, UK, Wadden Sea, and a Baltic population. The number of Grey seals in the Wadden Sea is steadily increasing. In 2006, a number of 1786 animals have been observed in the Dutch Wadden Sea (Reijnders, pers. comm.). This is however, a small percentage compared to the number of Grey seals in British waters, which counts approximately 120,000 individuals.

Harbour Porpoise (*Phocoena phocoena*) is a typical coastal species. It is mainly found in a wide area of the North Atlantic (including North Sea) and North Pacific. The most important calving and nursing site of the central North Sea is off the coast of the Wadden islands Sylt and Amrun (Sonntag et al., 1999). The Wadden Sea itself is not essential to the survival of this species, but is extensively used around March, when Harbour porpoise hunts for adult Herring that enters the Wadden Sea (Leopold, pers. comm.). The numbers of sightings along the Dutch coast are increasing significantly from 2000 onwards and porpoises are regularly observed in the Wadden Sea (Camphuysen & Peet, 2006).

Species: Phocoena phocoena
Common name: Harbour porpoise
IUCN Red List status: VU A1cd

Bottlenose dolphin (*Tursiops truncates*) is a typical coastal species as well. They reside along the southern North Sea coasts and were frequent visitors of the Wadden Sea until the Zuiderzee was closed off (1932). In recent years their presence is infrequent, although in 2004 large groups (tens to hundreds) were seen entering and leaving the Wadden Sea through the Marsdiep at Texel (Camphuysen & Peet, 2006).

Species:Tursiops truncates
Common name: Bottlenose dolphin
IUCN Red List status: DD

c) Migratory birds

The value of the Wadden Sea to migratory birds is eminent. A maximum of some 6.1 million birds are present in the international Wadden Sea *at the same time* (Blew & Südbeck, 2005). Each year on average 10 to 12 million birds migrate back and forth between their breeding grounds in Siberia, Scandinavia, Greenland and North-East Canada and their wintering grounds in Europe and Africa. These birds use the Wadden Sea for a short stay, as a major stop-over site for refueling or as a wintering area (Meltofte et al., 1994).

Figure A02.4 shows the important areas for waders along the East-Atlantic flyway. The southernmost area that is important for waders is the Bijagos Archipelago in Guinea-Bissau. This is an estuarine area with tidal flats and mangroves, covering 1570 km² (Zwarts, 1988). More to the north lies the Banc d'Arguin in Mauritania. This has a rather small intertidal area of approximately 535 km, including sebkhas and small areas covered with *Spartina* and mangroves (Hagemeijer & Smit, 2004). This is considerably smaller than the Wadden Sea, which has a total size of 9,500 km² of which 4,534 km² consists of intertidal flats (Meltofte et al. 2004). The Banc d'Arguin is the most important wintering ground and most birds that migrate to their breeding grounds up north make a stop-over in the Wadden Sea, especially those breeding in Scandinavia and on the Siberian tundras. The Wadden Sea itself is an irreplaceable stop-over on the migratory flyway. Apart from the Wadden Sea, various small Moroccan, Portuguese and French tidal flats may serve a role as "pit stop", especially during unfavourable weather conditions (northern wind) and so does the southwest of the Netherlands, but these are of insufficient size to host the whole population for an extended period of time (Smit & Piersma, 1989, Reneerkens et al., 2005).

The importance for migrating birds is of outstanding universal value from the point of view of conservation. For at least 52 geographically distinct populations of 41 bird species, more than 1% of the biogeographical population occur in the Wadden Sea. All in all, this means that a very special international responsibility of the Wadden Sea has to be stated for these populations and species (Meltofte et al., 1994; Rasmussen et al., 1996).

Figure A02.4: Important areas for waders along the East-Atlantic flyway. (1) Wadden Sea (2) Banc d'Arguin, Mauritania, (3) Bijagos Archipelago, Guinea-Bissau, (4) French tidal flats, (5) UK estuaries.

Meltofte et al. (1994) give an excellent overview of the international importance (an area is considered internationally important when more than 1% of a biogeographical population frequently is present in that area. The term internationally important originates from the Ramsar Convention and has been widely used since then in many international agreements and publications) of the Wadden Sea for birds:

Gulls and terns

Among gulls and terns, the Wadden Sea is of international importance for at least nine populations. Most of these also breed in internationally important numbers.

Ducks and geese

An estimated 2.0-2.5 million ducks and geese visit the Wadden Sea during the year. For 11 populations of waterfowl the area is of international importance. Almost the entire population of "Russian" Barnacle Goose *Branta leucopsis* and Dark-bellied Brent Goose *Branta b. bernicla* use the Wadden Sea. Largest waterfowl numbers occur in late autumn, when more than 1 million are regularly present. Wigeon *Anas penelope*, Shelduck *Tadorna tadorna* and Eider *Somateria mollissima* are most numerous. For the two latter species, the Wadden Sea is the most important moulting area for the north European populations.

Waders

An estimated 6-7 million waders visit the Wadden Sea each year. For about 30 populations of West Palearctic and Nearctic waders (20 species of coastal as well as inland waders) the area is of international importance, and in 12 of these more than half of the population occurs in the Wadden Sea. Almost the entire flyway populations of Grey Plover *Pluvialis squatarola*, Siberian Knot *Calidris c. canutus*, West Palearctic Dunlin *Calidris a. alpina* and Bar-tailed Godwit *Limosa lapponnica* visit the area each year.

Almost the entire population of the Dark-bellied Brent Goose and the entire North-European population of Dunlin use the Wadden Sea during several periods of their annual cycle (Blew & Südbeck, 2005). In addition, the Wadden Sea and the coastal zone of the adjacent North Sea are used by high numbers of moulting and feeding common eider and support the entire Northwest-European population of Common Shelduck during moult in summer. Without the Wadden Sea their populations would suffer heavily.

Moreover, for in total 34 species, the nutritious tidal flats and salt marshes are an indispensable stopping place on their migration route, or form their primary wintering or moulting habitat. Therefore the Wadden Sea can be considered essential for the existence of these species. A severe deterioration of the Wadden Sea implies a biodiversity loss on a world-wide scale. This applies primarily for the following 34 species (Blew & Südbeck, 2005):

1 Great Cormorant	13. Pied Avocet	25. Bar-tailed Godwit
2 Eurasian Spoonbill	14. Great Ringed Plover	26. Eurasian Curlew
3 Dark-bellied Brent Goose	15. Kentish Plover	27. Spotted Redshank
4 Barnacle Goose	16.Eurasian Golden Plover	28. Common Redshank
5 Common Shelduck	17. Grey Plover	29 Common Greenshank
6 Eurasian Wigeon	18. Northern Lapwing	30. Ruddy Turnstone
7 Common Teal	19. Red Knot	31. Black-headed Gull
8 Mallard	20. Sanderling	32. Common Gull
9 Northern Pintail	21. Curlew Sandpiper	33. Herring Gull
10 Northern Shoveler	22. Dunlin	34. Great Black-backed Gull
11 Common Eider	23. Ruff	
12 Eurasian Oystercatcher	24. Whimbrel	

Table A02.1: Bird species, for wich the Wadden Sea is essential.

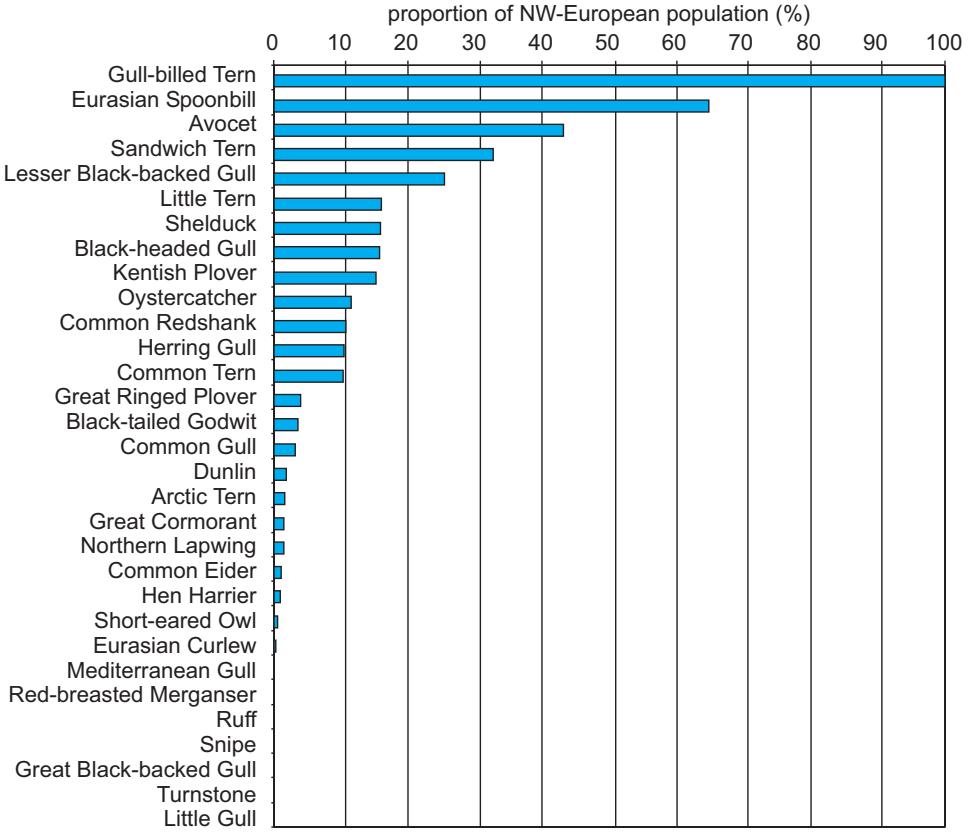


Figure A02.5: Maximum estimated numbers of migratory birds between 1992–2000 given as proportion of flyway populations (Wetlands International, 2002) for the entire Wadden Sea. From: Blew & Südbeck (2005).

d) Breeding birds

21 breeding bird species occur in the Wadden Sea at internationally important levels (at least 1% of the NW-European population). Many of these species (9) are also included in Annex I of the EC Birds Directive and deserve as such special protection. Another four species breed in rather low numbers in the Wadden Sea, but are included in Annex I as well (Ruff *Philomachus pugnax*, Little Gull *Larus minutus*, Mediterranean Gull *Larus melanocephalus* and Short-eared Owl *Asio flammeus*). In an international context, the Wadden Sea is a core breeding area for Eurasian Spoonbill, Avocet, Gull-billed Tern and Sandwich Tern. For each of these species more than 25% of the NW-European population breeds in the Wadden Sea area as shown in Figure A02.6 (Koffijberg et al., 2006).

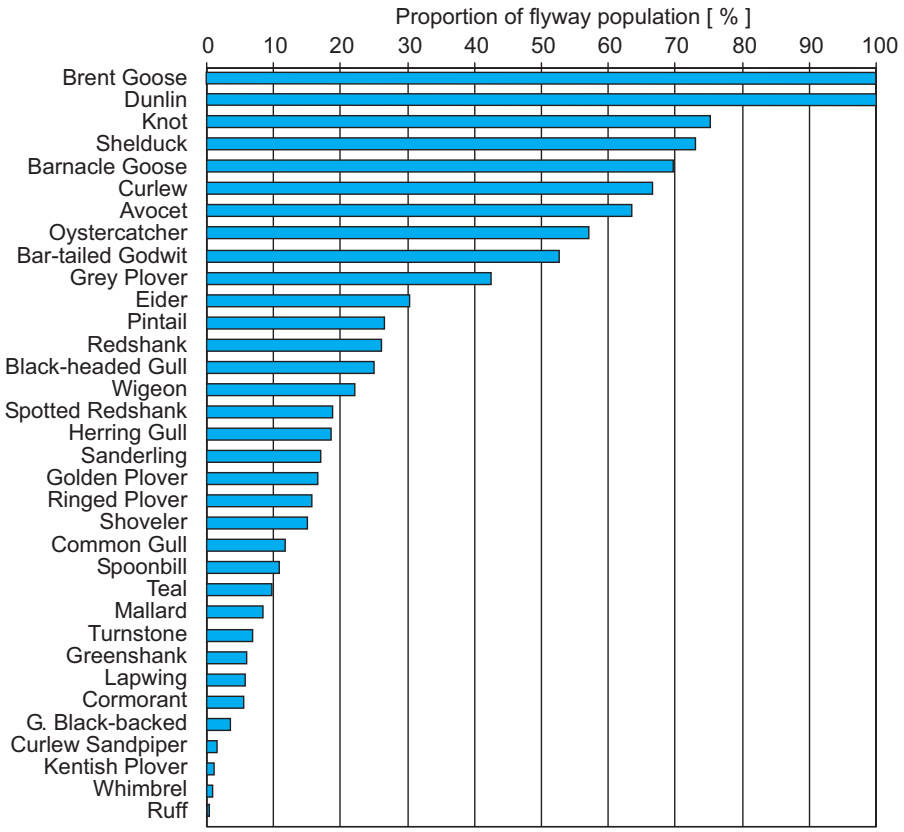


Figure A02.6: Comparison of breeding bird populations in the Wadden Sea in 2001 with NW-European population sizes given by BirdLife International (2004) and Thorup (2006, waders only). From: Koffijberg et al. (2006).

One of the breeding birds, the Black-tailed godwit, is found on the IUCN Red List. It has 4% of the NW-European population in the Wadden Sea, mainly the Dutch part.

Species: Limosa limosa
Common name: Black-tailed Godwit
IUCN Red List status: NT

Integrity and/or authenticity

Although bird migration is a global natural phenomenon that cannot be associated to a single site, the Wadden Sea is a vital and irreplaceable stepping stone that is considered a critically important 'mega-site' for bird migration. It is not just one of several stopover sites on the East-Atlantic flyway, but it is *the* essential stopover.

Because of the size, the length and the different conservation regimes most of the natural ecotopes of a barrier island saltmarsh and tidal flat system still exist. Especially the mutual dependency of ecotopes and completeness of an entire system can be found in the Wadden Sea. The quality of the area for migrating birds also is partly the result of the large size, which makes it easier to flee to other parts of the area when locally the conditions are less optimal.

Protection and management

The protection status of the Wadden Sea is laid down in many agreements and European and national legislation.

Comparative analysis

The Wadden Sea belongs to the largest wadden areas in the world. Although wadden areas occur in more locations around the world (Fig. 6), most of them have a distinctly different character.

The international Wadden Sea is, with 490,000 ha of tidal flats, by far the largest of Europe. It is 16 times larger than the second largest (Morecambe Bay, UK, 33,700 ha). Its area is even one and a half times larger than all the intertidal areas in the 155 British estuaries together. Apart from Morecambe Bay, the larger ones are the Wash (29,800 ha), the Solway Firth (24,600 ha), the Severn (16,900 ha), the Dee (13,000 ha), the Humber (13,500 ha) and the Thames (totalling 25,500 ha of smaller areas). Other large wadden areas in more or less temperate regions can be found along the East coast of Canada (Bay of Fundy, Hudson Bay), in Alaska (Copper River Delta), in East Asia (Yellow Sea), and West Asia (Persian Gulf). In tropical regions large areas are found in West-Africa (Guinea Bissau and

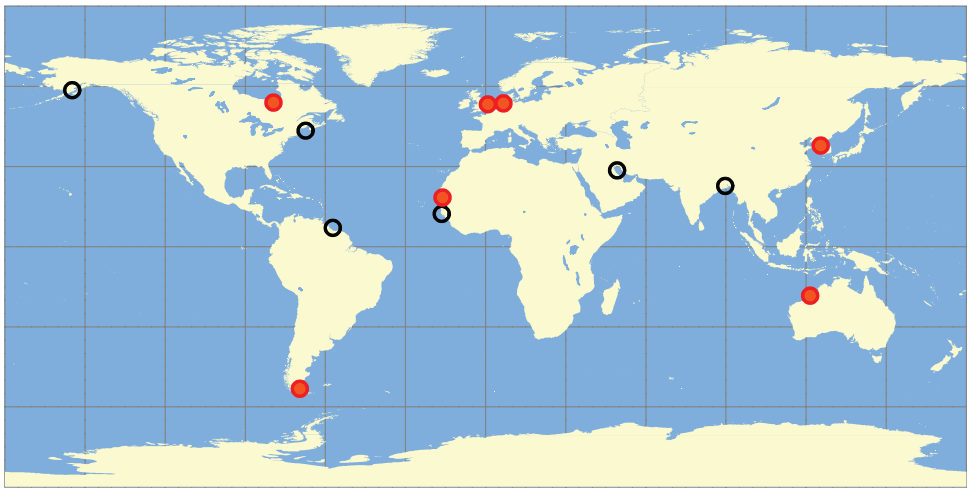


Figure A02.7: Important and large wadden areas, filled circles represent areas where shellfish are an important food source (after Van de Kam et al., 1999).

Mauritania), South-East Asia (China, Vietnam and Irian Jaya), Northwest Australia and in Suriname (Van de Kam et al., 1999).

The Wadden Sea climate cannot be compared to those in tropical or arctic regions. Apart from that, the character of the Wadden Sea, having a tidal flat and barrier-island system, is of outstanding universal value.

4. References

Asmus, R., Jensen, M.H., Murphy, D. & Dörffer, R,. 1998. Primary production of the microphytobenthos, phytoplankton and the annual yield of macrophytic biomass in the Sylt-Rømø Wadden Sea (In German, English abstract). In: C. Gätje & K. Reise (Eds.) Ökosystem Wattenmeer – Austausch-, Transport-und Stoffumwandlungsprozesse. Springer-Verlag Berlin Heidelberg, pp. 367-391.

Azovsky, A.I., Chertoprood, M.V., Kucheruk, N.V., Rybnikov, P.V. & Sapozhnikov, F.V., 2000. Fractal properties of spatial distribution of intertidal benthic communities. Marine Biology 136: 581-590. DOI 10.1007/s002270050718.

Bakker, J.P., Bunje, J., Dijkema, K., Frikke, J., Hecker, N. Kers, B. , Körber, P., Kohlus, J. & Stock, M., 2005. Salt Marshes. In: Essink, K. Dettmann, C. Farke, H. Laursen, K. Lüerszen, G. Marencic, H & Wiersinga, W. (Eds.). Wadden Sea Quality Status Report 2004. Wadden Sea Ecosystem No. 19 Trilateral Monitoring and Assessment Group, Common Wadden Sea Secretariat, Wilhelmshaven, Germany. pp. 163-179.

Baptist, M.J., 2005. Biogeomorphology. In: Schwartz, M. (Ed.). Encyclopaedia of Coastal Science, pp. 192-193. ISBN 1-4020-1903-3.

Beets, D.J. & van der Spek, A.J.F., 2000. The Holocene evolution of the barrier and the back-barrier basins of Belgium and the Netherlands as a function of late Weichselian morphology, relative sea-level rise and sediment supply. Geologie en Mijnbouw / Netherlands Journal of Geosciences 79(1): 3-16.

Berghahn, R., 1987. The Wadden Sea as a nursery for fish and crustacean species. In: Proceedings of the 5th International Wadden Sea Symposium, Sep. 29th -Oct. 3rd 1986. Ed. by S. Tougaard & S. Asbirk. The National Forest and Nature Agency and the Museum of Fisheries and Shipping, Esbjerg, 69–85.

BirdLife International, 2004. Birds in Europe: population estimates, trends en conservation status. BirdLife International, Cambridge.

Blew, J. & Südbeck, P. (Eds.), 2005. Migratory Waterbirds in the Wadden Sea 1980-2000. Wadden Sea Ecosystem No. 20. Common Wadden Sea Secretariat, Trilateral Monitoring and Assessment Group, Joint Monitoring Group of Migratory Birds in the Wadden Sea, Wilhelmshaven, Germany.

Cadée, G. C. & Hegeman, J., 1974a. Primary production of phytoplankton in the Dutch Wadden Sea. Neth. J. Sea Res. 8, 240-259.

Cadée, G. C. & Hegeman, J., 1974b. Primary production of the benthic microflora living on tidal flats in the Dutch Wadden Sea. Neth. J. Sea Res. 8, 260-291.

Camphuysen, K. & Peet, G., 2006. Whales and Dolphins of the North Sea. 's-Graveland, Fontaine Uitgevers bv. 159 p.

Cleveringa, J. & Oost, A., 1999. The fractal geometry of tidal-channel systems in the Dutch Wadden Sea. Geologie en Mijnbouw 78: 21-30. DOI 10.1023/A:1003779015372.

Dankers, N., Dijkema, K.S., van Franeker, J.A., Leopold, M., Smit, C.J. & Wolff, W.J., 1993. Hst. 2: Inleiding voor de regio's van de maritieme invloedsfeer; Hst. 3: Afgesloten zeearmen; Hst. 4: Getijdegebied; Hst. 5: Noordzee. In: Leerdam, A. van, M.J. Wassen & N.Dankers. Onderzoek nagenoeg-natuurlijke referentie-ecosystemen. Interfacultaire Vakgroep Milieukunde, RU Utrecht / DLO-Instituut voor Bos-en Natuuronderzoek, Utrecht; 12-13; 14-18; 19-29; 30-36.

Dankers, N., Meijboom, A., Cremer, J.S.M., Dijkman, E.M., Hermes, Y. & te Marvelde, L., 2003. Historische ontwikkeling van droogvallende mosselbanken in de Nederlandse Waddenzee. EVA-II-Alterra raport 876, 114 pp.

Dankers, N., Meijboom, A., de Jong, M., Dijkman, E., Cremer, J. & van der Sluis, S., 2004. Het ontstaan en verdwijnen van droogvallende mosselbanken in de Nederlandse Waddenzee. Alterra Rapport 921, 114 pp.

Dijkema K.S. & Wolff, W.J., 1983. Flora and vegetation of the Wadden Sea Islands and coastal areas. Report 9 of Wadden Sea Working Group. 413 pp. In: Wolff, W.J., 1983. Ecology of the Wadden Sea. Balkema Rotterdam (3 volumes).

Dijkema, K.S., Beeftink, W.G., Doody, J.P., Gehu, J.M., Heydemann, B. & Rivas Martinez, S., 1984. Salt Marshes in Europe.

Council of Europe, Nature and Environment: Series 30, Strasbourg. 178 pp.

Essink, K., Dettmann, C., Farke, H., Laursen, K., Lüerszen, G., Marencic, H. & W. Wiersinga, W., (Eds), 2004. Wadden Sea Quality Status Report 2004. Wadden Sea Ecosystem No. 19 Trilateral Monitoring and Assessment Group, Common Wadden Sea Secretariat, Wilhelmshaven, Germany p. 211-218.

Hagemeijer, E.J.M., Smit C.J. (Eds.), de Boer, P., van Dijk, A.J., Ravenscroft, N., van Roomen, M.W.J. & Wright, M. 2004. Wader-and waterfowl count on the Banc d'Arguin, Mauritania, January-February 2000. WIWO report 81, Beek-Ubbergen, 146 p.

Halley, J.M., Hartley, S., Kallimanis, A.S., Kunin, W.E., Lennon, J.J. & Sgardelis, S.P., Uses and abuses of fractal methodology in ecology. Ecology Letters 7: 254-271.

Hovenkamp, F. & van der Veer, H.W., 1993. De visfauna van de Nederlandse estuaria: Een vergelijkend onderzoek. Den Burg, NIOZ: 121 p.

Kam, J. van, Ens, B., Piersma, T. & Zwarts, L.,1999. Ecologische atlas van de Nederlandse wadvogels. Haarlem, Schuyt, 368p. ISBN 906097509X.

Koffijberg, K., Dijksen, L., Hälterlein, B., Laursen, K., Potel, P. & Südbeck, P. 2006. Breeding Birds in the Wadden Sea in 2001 -Results of the total survey in 2001 and trends in numbers between 1991-2001. Wadden Sea Ecosystem No. 22. Common Wadden Sea Secretariat, Trilateral Monitoring and Assessment Group, Joint Monitoring Group of Breeding Birds in the Wadden Sea, Wilhelmshaven, Germany.

Koppel, J. van der, Rietkerk, M., Dankers, N. & Herman, P.M.J. 2005. Scale-Dependent Feedback and Regular Spatial Patterns in Young Mussel Beds. The American Naturalist 165(3): E66-E77.

Kromkamp, J.C., de Brouwer, J.F.C., Blanchard, G.F., Forster, R.M. & Créach, V., (Eds.), 2006. Functioning of microphytobenthos in estuaries. Amsterdam, Royal Netherlands Academy of Arts and Sciences. ISBN 90-6984-453-2.

Levin, S.A. The Problem of Pattern and Scale in Ecology: The Robert H. MacArthur Award Lecture. Ecology 73(6): 1943-1967.

MacIntyre, H., Geider, R.J. & Miller, D.C., 1996. Microphytobenthos: The Ecological Role of the "Secret Garden" of Unvegetated, Shallow-Water Marine Habitats. I. Distribution, Abundance and Primary Production. Estuaries 19, No. 2A, 186-201.

Möbius, K., 1877. Die Auster und die Austernwirthschaft. Wiegund, Hempel and Parey. Berlin, 1-126.

Meltofte, H., Blew, J., Frikke, J., Rösner, H-U & Smit, C.J., 1994. Numbers and distribution of waterbirds in the Wadden Sea; Results and evaluation of 36 simultaneous counts in the Dutch-German-Danish Wadden Sea 1980-1991. IWRB Publication 34 / Wader Study Group Bulletin 74, Special Issue.

Nordheim, E von, Norden Andersen, O., Thissen, J. & Merck, T. , 1996. General Introduction to the Lists of Threatened Biotopes, Flora and Fauna of the Trilateral Wadden Sea Area. Helgoländer Meeresunters. 50, Suppl, 1-8.

Rasmussen, L.M., Norden Andersen, O.G., Frikke, J., Laursen, K., Salvig, J., Fleet, D.M., Hälterlein, B., Heckenroth, H., Merck, T., Rösner, H-U., Südbeck, P., Wolff, W.J. & Thissen, J.B.M., 1996. Red List of Birds of the Wadden Sea. Helgoländer Meeresunters. 50, Suppl, 113-128.

Reise, K., 2002. Sediment mediated species interactions in coastal waters. Journal of Sea Research 48: 127-141.

Reneerkens, J., Piersma, T. & Spaans, B., De Waddenzee als kruispunt van vogeltrekwegen; Literatuurstudie naar de kansen en bedreigingen van wadvogels in internationaal perspectief. NIOZ-rapport 2005-4. ISNN 0923-3210.

Smit, C.J. & Wolff, W.J., 1980. Birds of the Wadden Sea; Final report of the section Birds of the Wadden Sea Working Group. Report 6 of the Wadden Sea Working Group, Stichting Veth tot Steun aan Waddenonderzoek, Leiden. ISBN 90 6191 056 0.

Smit, C.J. & Piersma, T., 1989. Numbers, midwinter distribution, and migration of wader populations using the East Atlantic flyway. In: H. Boyd & J.-Y. Pirot (eds.), Flyways and reserve networks for water birds. IWRB Special Publ. 9, Slimbridge, 24-63.

Ssymank, A. & Dankers, N., 1996. Red List of Biotopes and Biotope Complexes of the Wadden Sea Area. Helgoländer Meeresunters. 50, 9-37.

Stallins, J.A., 2006. Geomorphology and ecology: Unifying themes for complex systems in biogeomorphology. Geomorphology 77: 207-216.

Thorup, O. (Ed.), 2006. Breeding waders in Europe: a year 2000 assessment. International Wader Studies 14, 3-131.

Turner, M.G., 1989. Landscape ecology: The Effect of Pattern of Process. Annu. Rev. Ecol. Syst. 20:171-197.

Vlas, J. de, Brinkman, B., Buschbaum, C., Dankers, N., Herlyn, M., Sand Kristensen, P., Millat, G. Nehls, G., Ruth, M., Steenbergen, J. &Wehrman, A. 2005. Intertidal Blue Mussel beds. In: Essink, K., Dettmann, C., Farke, H., Laursen, K., Lüerszen, G., Marencic, H. & Wiersinga, W. (Eds). Wadden Sea Quality Status Report 2004. Wadden Sea Ecosystem No. 19 Trilateral Monitoring. and Assessment Group, Common Wadden Sea Secretariat, Wilhelmshaven, Germany. p. 190-200.

Wetlands International, 2002. Waterbird Population Estimates -Third Edition. Wetlands International Global Series No. 12, Wageningen, The Netherlands. 182 p.

Wolff, W.J. 1983. Ecology of the Wadden Sea. Balkema Rotterdam (3 volumes) Zwarts, L. 1988. Numbers and distribution of coastal waders in Guinea-Bissau. *Ardea*, **76,** 42-55.

Sunset over the Wadden Sea (Photo: Klaus Janke).

Annex 03: A Comparative Analysis of the Wadden Sea for the Nomination on the World Heritage List

Baptist, M.J., Dankers, N. and Smit, C. 2007. Wageningen University and Research Centre.

1. Introduction

The format for the nomination of properties for inscription in the World Heritage List requires a comparative analysis (including state of conservation of similar properties) of the similar sites, whether on the World Heritage List or not. The comparison should outline the similarities the nominated property has with other properties and the reasons that make the nominated property stand out. The comparative analysis should aim to explain the importance of the nominated property both in its national and international context.

The objective is: a comparative table in which the Wadden Sea area to be nominated for inscription on the World Heritage List is compared with similar areas in the world, listed and non-listed.

2. Approach

2.1. Listed sites

As a first step in the comparison analysis, the currently 31 listed World Heritage sites with significant marine components and the 24 World Heritage coastal island sites with no (or insignificant) marine areas have been selected for further analysis. As a second step, sites have been selected that that host a high biodiversity and/or waterfowl and migratory birds. This results in 9 World Heritage sites, namely Galapagos National Park and Marine Reserve, Everglades National Park, Great Barrier Reef, Doñana National Park, The Sundarbans, Banc d´Arguin National Park, Fraser Island, Whale Sanctuary of El Vizcaíno and Greater St. Lucia Wetland Park.

Table A03.1: Preselected World Heritage sites, sizes and major biophysical setting.

World Heritage Site	Size (km²)	Biophysical setting
Galapagos National Park and Marine Reserve	7,665	Volcanic archipelago and ocean
Everglades National Park	5,929	Freshwater and coastal marshes, mangrove swamps
Great Barrier Reef	348,700	Coral reef system and ocean
Donana National Park	507	Coastal marshlands and dunes
Sundarbans (Bangladesh & India)	7,280	Deltaic islands, waterways, intertidal area with extensive mangrove cover
Banc d´Arguin National Park	12,000	Mudflats, dunes, islands
Fraser Island	1,663	Sand island
Whale Sanctuary of El Vizcaíno	3,710	Lagoons with some mangrove and seagrass
Greater St. Lucia Wetland Park	2,396	Coastal lakes, dunes and continental shelf

Firstly, it must be noted that all nine properties are located in a different biogeographical region than the Wadden Sea. The only European property is Doñana. The Doñana is located along the borders of the North-east Atlantic Ocean Region, whereas the Wadden Sea is located in the North Sea Region (EEA, 2002).

Secondly, many of the listed properties contain islands. The Galapagos are volcanic islands in an ocean surrounding, the Great Barrier reef has many coral islands, Fraser Island is an enormous sandy island, the Sundarbans consist of deltaic islands, Banc d'Arguin contains (partly rocky) islands and Florida Bay, which covers about 1800 km² of the Everglades National Park, contains hundreds of mangrove covered islands. However, the characteristics of these islands differ markedly from that of the Wadden islands.

Thirdly, and more important for the comparison with the Wadden Sea, the properties Sundarbans, Everglades (i.e., Florida Bay), Doñana and Banc d'Arguin contain intertidal flats within the property. The Wadden Sea is characterised by extensive contiguous sand flats and mud flats. The Sundarbans contain plots of mudflats mainly in the lee side of dunes, Florida Bay is a shallow lagoon with mudflats fringing the mangrove covered islands, Doñana has a relatively small proportion of mudflats on the inner side along the banks of the Guadalquivir River, Greater St. Lucia has hardly any intertidal area and El Vizcaíno has some intertidal area covered with mangrove and seagrass.

The only World Heritage property that has extensive mudflats and with which the Wadden Sea can be compared, is the Banc d´Arguin National Park in Mauritania. Approximately 630 km² consists of intertidal mudflats (Hughes & Hughes, 1992). This is considerably smaller than the Wadden Sea, which has 4,534 km² of bare intertidal areas (Meltofte et al., 2004). Moreover, the Banc d'Arguin is of great importance for Palearctic migrating birds, as is the Wadden Sea. However, the Banc d'Arguin is located in a different biogeographical region and does not have barrier islands. In fact, the comparative analysis in the nomination dossier of the Parc national du Banc d'Arguin does not even consider the Wadden Sea as a comparable site. In their dossier a comparison is made with other areas with a combination of hot desert and coastal features.

2.2. Non-listed sites

The non-listed sites have been selected from various sources, in particular the overview by Deppe (2000). This overview is based on a broad number of sources (e.g. Ramsar Wetlands of International Importance, National Parks, Special Protected Areas, Wildlife Rerves).

Deppe (2000) described and compared 350 intertidal mudflat sites worldwide. Intertidal mudflat coasts may result from various geological and present day processes. At low tidal ranges lagoon-type mudflats may develop, at macrotidal ranges intertidal areas attached to the coast may develop, and many estuaries, bays and deltas contain mudflats.

Selection criteria

To be comparable to the Wadden Sea, which has over 4500 km² of intertidal mudflats, a size criterion of a minimum of 300 km² is applied to the long-list of 350 mudflat sites. This results in a total of 44 sites that qualify, Table A03.2.

Site	Size (km²)	Coordinates	Type
Aqajarua-Sllorsuaq (Greenland)	300	69°40'N 52°00'W	Estuary
Qinnquata Marra-Kuussuaq (Greenland)	6000	69°56'N 54°17'W	Estuary
Baie du Mont Saint-Michel (France)	6200	48°40'N 01°40'W	Bay & estuary
Oosterschelde (Netherlands)	3800	51°30'N 04°10'E	Estuary
Kandalaksja Bay (Russia)	20800	65°N 35°E	Bays & estuaries
Karaginsky Island (Russia)	1936	58°45'N 163°42'E	Estuaries & open flats
Morecambe Bay (UK)	359	54°07'N 02°57'W	Bay & deltaic barrier
The Wash (UK)	622	52°56N 00°17'E	Bay & estuary
Upper Solway Flats & Marshes (UK)	307	54°54'N 03°25'W	Estuary
Archipelago dos Bijagos (Guinea-Bissau)	15700	12°20'N 16°00'W	Island coast & estuaries
St. Lucia (South-Africa)	1555	28°00'S 32°28'E	Estuary
Bahia Blanca (Argentine)	3000	38°50'S 62°00'W	Bay & estuary
Bahia de Samborombon (Argentine)	2440	35°47'S 57°50'W	Estuary
San Antonio Oeste Rio Negro (Argentine)	350	64°55'S 40°45'W	Bay
Dewey Soper (Canada)	8159	66°10'N 74°00'W	Open flats
Hudson Bay (Canada)	24087	52°30'N 84°30'W	Bay, estuaries & open flats
Queen Maud Gulf (Canada)	62782	67°00'N 102°00'W	Bay, estuaries & open flats
Bay of Fundy (Canada)	620	45°30'N 64°20'W	Bay & estuaries
Bigi Pan (Suriname)	683	05°55'N 56°45'W	Estuary & open flats
Wia Wia (Suriname)	900	05°56'N 54°55'W	Estuary & open flats
Chesapeake Bay (USA)	450	38°00'N 76°20'W	Bay & estuaries
Delaware Bay (USA)	512	39°11'N 75°14'W	Bay & estuaries
Georgia Bight (USA)	8000	32°17'N 80°35'W	Barrier islands & estuaries
Copper River Delta (USA)	1513	60°30'N 145°00'W	Deltaic barrier & estuaries
Delta del Rio Colorado (Mexico)	2500	31°50'N 114°59'W	Estuary
Khuran Straits (Iran)	1000	26°45'N 55°40'E	Estuary & deltaic barrier
Khor-al Amaya & Khor Musa (Iran)	4000	30°30'N 48°45'E	Estuaries & deltaic barriers
Kuwait Bay (Kuwait)	2000	29°20'N 48°00'E	Bay
Ras Al Khaymas (UAE)	3000	24°50'N 53°00'E	Barrier beach ridges
Gulf of Khambhat (India)	2500	21°50'N 72°23'E	Estuary
Korea Bay (China)	757	39°50'N 124°00'E	Estuary & bay
Liaodong Wan (China)	1247	40°00'N 121°50'E	Bay
Yellow river delta (China)	3712	37°50'N 118°50'E	Estuary
Korea Bay (North Korea)	1340	39°00'N 125°00'E	Estuary & bay
Yellow Sea coast (North Korea)	932	37°50'N 126°00'E	Estuaries & deltaic barriers
Yellow Sea coast (South Korea)	2900	36°00'N 127°00'E	Estuaries & deltaic barriers
Gulf of Thailand (Thailand)	400	13°20'N 100°25'E	Estuary & bay
Bowling Green Bay (Australia)	355	19°27'S 147°15'E	Estuary & bay
Corner Inlet (Australia)	672	38°45'S 146°32'E	Estuary & deltaic barriers
Eighty-mile Beach (Australia)	1250	19°29'S 120°35'E	Estuary & bays
Moreton Bay (Australia)	1133	27°20'S 153°10'E	Estuary & deltaic barriers
Roebuck Bay (Australia)	550	18°07'S 122°16'E	Bay
Shoalwater & Corio Bays (Australia)	2391	22°40'S 150°17'E	Estuaries & bay
Western Port (Australia)	593	38°22'S 145°17'E	Estuaries & deltaic barriers

Table A03.2: Mudflat sites in the world larger than 300 km² (in many cases the total size of the site is given, this is usually larger than the size of the intertidal flats).

The Wadden Sea mudflats are characterised by their location in tidal inlets of barrier islands. They contain a sequence of large and small ebb and flood gullies and their energy gradients follow from the morphology. The Wadden Sea (geological name: German Bight) is a mesotidal barrier island system that only has minor river influences fringing the flat and low-lying coastal plain. Most of the mudflat systems in the world are connected to estuaries and bays. Some are connected with barrier islands that are closely related to rivers and their deltas, such as the Mississippi delta. Only 5% of these deltaic barrier islands are found in North America and Europe, due to differing sea level rise history (Stutz & Pilkey, 2002). In North America and Europe, therefore, the barrier islands have a different geological origin. A second criterion, therefore, is the presence of barrier islands that do not have a river delta origin.

Of all sites larger than 300 km² this results

in one comparable area: The Georgia Bight. The Georgia Bight (also named South Atlantic Bight) extends for a distance of 1200 km between Cape Hatteras in North Carolina to Cape Canaveral in Florida. Both the German Bight and the Georgia Bight are mesotidal barrier coasts that fall within the mixed energy / tide-dominated classification and both have a coastal development affected by Holocene sea level rise.

Comparing to non-listed areas, in the European context the Wadden Sea is unique in every respect in the European context. The Ria Formosa is a barrier island system and lagoon, but is a lot smaller (160 km^2) and does not contain the complex system of habitats and biotopes as the Wadden Sea. Morecambe Bay and The Wash have large mudflat areas, but are coastal bays, not barrier island coasts and they lack the specific morphological setting.

Other intertidal areas world-wide in the temperate region do not compare to the Wadden Sea. The Yellow Sea coast of China and Korea has a comparable mudflat size. However, there are no barrier islands like the Wadden Sea, the biophysical and biological features are different and the area is located on a different flyway. The Bay of Fundy and Delaware Bay and Chesapeake Bay for instance, have large mudflat areas, but have a very different morphological setting. Other areas are often located in different climate zones, but more important, do not have the non-deltaic barrier coast.

3. Comparison

Table A03.3 presents the comparison of the Wadden Sea with the two most similar areas. The Banc d'Arguin is comparable to the Wadden Sea for its function in the East Atlantic Flyway. Moreover, both areas are indispensable for the survival of millions of migrating birds and are thus linked over a distance of more than 4000 km. Apart from this, the Banc d'Arguin is situated in a different climate, has a very different morphological genesis and morphology and has a significantly smaller mudflat area, which is for the majority covered by seagrass.

The most important (and major) difference between the Georgia Bight system and the Wadden Sea is that the Wadden Sea has open intertidal flats fringed by salt marshes, whereas the tidal basins along the Georgia Bight comprise tidal channels, narrow intertidal flats fringing the channels, and huge expanses of Spartina marsh which occupy what would otherwise have been open intertidal flats. The reason why Spartina has managed to encroach upon the former tidal flats is the large supply of mud (grain sizes <0.063 mm) to the coast by the local rivers. As a consequence, vertical accretion along the fringes of the marsh was so rapid that Spartina was able to occupy almost the entire intertidal area. The Georgia Bight tidal system thus looks very different from the Wadden Sea and also differs substantially in its ecology. A major difference to the Wadden Sea with a dominance of bare mudflats is a prevalence of the saltmarsh habitat while mudflats are marginal. At first glance, both systems are quite similar in their primary production. It should be noted, however, that the Wadden Sea is located between 52° 53' N – 54° 53' N, whereas the Georgia Bight is located between 28° 28' N - 35° 13' N, and receives considerably more light.

4. Conclusion

The Wadden Sea is to be regarded as of outstanding and unique universal value compared to similar areas world-wide.

FEATURES	Wadden Sea (maps in nomination dossier)	Banc d'Arguin (map below)	Georgia Bight (map below)
designation WH	to be nominated	1989	not WH
country	Germany / Netherlands	Mauritania	USA
climate zone	temperate	continental, arid sub-tropics, dry	temperate
description setting	mixed energy to tide-dominated mesotidal barrier coast (not deltaic)	back barrier islands and open mud flats, relic of former deltas	mixed energy to tide-dominated mesotidal barrier coast (not deltaic)
total area	10,000 km^2	12,000 km^2 (50% marine)	ca. 8,000 km^2
mudflat area	4,500 km^2	630 km^2	ca. 300 km^2
tidal differences / range	1.5 – 3.5 m	2.1 m	0.8 – 2.5 m
mean wave height / range	1.0 – 2.0 m	1.4 m	0.6 – 1.0 m
contiguous character	large and contiguous area of intertidal habitats	contiguous between Cap Timiris and Pointe Minou, isolated section at Cap Blanc	not a contiguous intertidal system
habitats, biotopes	complex mosaic of bare intertidal flats fringed by saltmarshes, tidal channels, seagrass meadows, mussel beds	sand dunes, coastal swamps, small islands, intertidal areas with 80% seagrass cover	tidal channels with narrow band of bare intertidal flat. Intertidal almost completely covered by Spartina and Juncus saltmarshes
salt marshes km^2	310 km^2	591 km^2	4,237 km^2
mangroves km^2	none	31 km^2 mangrove Avicennia africana	some mangrove Avicennia germinans
major estuaries	5 estuaries	0 estuaries	13 estuaries
migrating birds	6,1 million present at the same time; on average 10 to 12 million each year; East Atlantic Flyway	2,1 million over-wintering birds (106 species) East Atlantic Flyway	Important stop-over for millions of migrating birds West Atlantic Flyway
productivity	Primary production (gC/m^2/y): phytoplankton 100-200 microphytes 150 seagrass 500 macrophytes 500-1000	Primary production (gC/m^2/d): phytoplankton 2.1-8.9	Primary production (gC/m^2/y): phytoplankton 200-400 microphytes 60 seagrass 150-700 macrophytes 800-2000
State of conservation	RAMSAR site, PSSA by the IMO, MAB by UNESCO, EU Natura 2000, EU WFD, contracting party of African-Eurasian Waterbird Agreement (AEWA)	RAMSAR site, National Park, has Fondation Internationale du Banc d'Arguin (FIBA) as management authority, not contracting party of AEWA	Not contiguously protected. Two Western Hemisphere Shorebird Reserves, Carolinian-South Atlantic MAB, no RAMSAR sites, no PSSA.

Table A03.3: Comparison of the Wadden Sea with Banc d'Arguin and Georgia Bight.

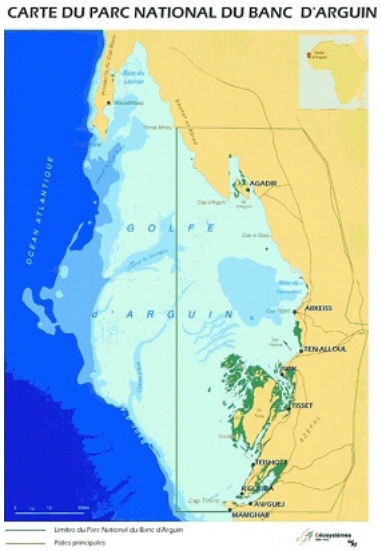


Figure A03.1(left): Overview map of National Park Banc d'Arguin (source: http://effectivempa.noaa.gov/images/maps/bancdarguin_map_lg.jpg)

Figure A03.2 (right): Overview map of Georgia Bight (source: www.dnr.sc.gov/marine/sertc/index/html)

5. References

African-Eurasian Waterbird Agreement, http://www.unep-aewa.org/.

Alexander, C. & Robinson, M., 2004. Semi-annotated bibliography of barrier island studies Applicable to Georgia Back-Barrier Islands. Report from the Georgia Coastal Zone Management Program.

Anthony, E.J. & Orford, J.D., 2002. Between Wave- and Tide-Dominated Coasts: the Middle Ground Revisited. Journal of Coastal Research SI36, 8-15.

Berghuis, E.M., Duineveld, G.C.A. & Hegeman, J., 1993. Primary production and distribution of phytopigments in the water column and sediments on the upwelling shelf off the Mauritanian coast (Northwest Africa). Hydrobiologia 258 : 81-93.

Dame, M., Allen, D., Mallin, M., Montague, C., Lewitus, A., Chalmers, A., Gardner, R., Gilman, C., Kjerfve, B., Pinckney, J. & Smith, N.,2000. Estuaries of the South Atlantic Coast of North America: Their Geographical Signatures. Estuaries 23(6): 793-819.

Deppe, F, 2000. Intertidal Mudflats Worldwide. Wilhelmshaven, Common Wadden Sea Secretariat (CWSS), 100 p.

Duineveld, G.C.A., de Wilde, P.A.W.J., Berghuis, E.M. & Kok, K., 1993. The benthic infauna and benthic respiration off the Banc d'Arguin (Mauritania, Northwest Africa). Hydrobiologia 258 : 107-117.

Engle, V.D. & Summers, J.K., 1999. Latitudinal gradients in benthic community composition in Western Atlantic estuaries. Journal of Biogeography 26: 1007-1023.

EEA, 2002. European Environment Agency Biogeographical Regions and Seas: http://reports.eea.europa.eu/report_2002_0524_154909/en.

Fondation Internationale du Banc d'Arguin (FIBA), http://www.fibarguin.org/.

Jager, Z., 1993. The distribution and abundance of young fish in the Banc d'Arguin, Mauritania. Hydrobiologia 258 : 185-196.

Hagemeijer, E.J.M., Smit C.J. (Eds.), de Boer, P., van Dijk, A.J., Ravenscroft, N., van Roomen, M.W.J. & Wright, M., 2004. Wader- and waterfowl count on the Banc d'Arguin, Mauritania, January-February 2000. WIWO report 81, Beek-Ubbergen, 146 p.

Hughes R. & Hughes, S., 1992. Directory of African Wetlands. IUCN, Switzerland /UNEP, Nairobi / WCMC, Cambridge, UK.

Man and the Biosphere Program, http://www.unesco.org/mab/.

Meltofte, H., Blew, J., Frikke, J., Rösner, H-U. & Smit, C.J., 1994. Numbers and distribution of waterbirds in the Wadden Sea; Results and evaluation of 36 simultaneous counts in the Dutch-German-Danish Wadden Sea 1980-1991. IWRB Publication 34 / Wader Study Group Bulletin 74, Special Issue.

Particularly Sensitive Sea Areas (PSSA), http://www.imo.org/.

Ramsar Convention on Wetlands, http://www.ramsar.org/.

Rousseau, S. & Forget, P., 2004. Ocean wave mapping from ERS SAR images in the presence of swell and wind waves. Scientia Marina 68(1): 1-5.

Searles, R.B., 1984. Seaweed biogeography of the mid-Atlantic coast of the United States. Helgoländer Meeresuntersuchüngen 38: 259-271.

Stallins, J.A., 2000. Barrier Island Morphology and Dune Vegetation Pattern and Process in the Georgia Bight. Georgia, University of Georgia, PhD-thesis, 217 p.

Stutz, M.L. & Pilkey, O.H., 2002. Global distribution and morphology of deltaic barrier island systems. Journal of Coastal Research SI 36: 694-707.

Thorsell, J., R. & Sigaty, T., 1997. A global overview of wetland and marine protected areas on the World Heritage list. Gland, Switzerland, IUCN, 47 p.

UNESCO, 1989. IUCN Technical Evaluation Banc d'Arguin National Park. 17 p.

Vermaat, J.E., Beijer, J.A.J., Gijlstra, R., Hootsmans, M.J.M., Philippart, C.J.M., van der Brink, N.W., & van Vierssen, W., 1993. Leaf dynamics and standing stocks of intertidal Zostera noltii Horneman and Cymodocea nodosa (Ucria) Ascherson on the Banc d'Arguin (Mauritania). Hydrobiologia 258: 59–72.

Watson, C., Hayes, C., McCauley, J., Milliken, J., 2004. The South Atlantic Migratory Bird Initiative – An Integrated Approach to Conservation of "All Birds Across All Habitats". USDA Forest Service Gen. Tech. Rep. PSW-GTR-191.

Western Hemisphere Shorebird Reserves network, http://www.whsrn.org/.

Wigh, R. A. Review of bird species on the South Atlantic Bight. Report on skidaway.net.

Wolff, W.J., van der Land, J., Nienhuis, P.H. & de Wilde, P.A.W.J., 1993. The functioning of the ecosystem of the Banc d'Arguin, Mauritania : a review. Hydrobiologia 258 : 211-222.

Issues of the Publication Series „Wadden Sea Ecosystem“

No. 1: Breeding Birds in the Wadden Sea 1991. 1994.
No. 2: Migratory Waterbirds in the Wadden Sea1992/93. 1994.
No. 3: Guidelines for Monitoring of Breeding Birds in the Wadden Sea (in Dutch, German, Danish). 1995.
No. 4: Breeding Birds on Census Arteas 1990 until 1994. Status of Shorelark, Twite and Snow Bunting in the Wadden Sea. 1997.
No. 5: Migratory Waterbirds in the Wadden Sea 1993/94. 1996.
No. 6: Trilateral Monitoring and Assessment Program. TMAP Expert Workshops 1995/96. 1996.
No. 7: Assessment of the Wadden Sea Ecosystem. 1997.
No. 8: Monitoring Breeding Success of Coastal Birds. Monitoring Pollutants in Coastal Bird Eggs in the Wadden Sea. 1998.
No. 9: Wadden Sea Quality Status Report 1999. 1999.
No. 10: Breeding Birds in the Wadden Sea in 1996. 2000.
No. 11: Contaminants in Bird Eggs in the Wadden Sea. Spatial and Temporal Trends 1999 - 2000. 2001.
No. 12: Lancewad. Landscape and Cultural Heritage in the Wadden Sea Region. 2001.
No. 13: Final Report of the Trilateral Working Group on Coastal Protection and Sea Level Rise. 2001.
No. 14: Wadden Sea Specific Eutrophication Criteria. 2001.
No. 15: Common and Grey Seals in the Wadden Sea. TSEG-plus Report March/June 2001.2002.
No. 16: High Tide Roosts in the Wadden Sea. A Review of Bird Distribution, Protection Regimes and Potential Sources of Anthropogenic Disturbance. 2003.
No. 17: Management of North Sea Harbour and Grey Seal Populations. Proceedings of the International Symposium at EcoMare, Texel, The Netherlands November 29 - 30, 2002. 2003.
No. 18: Contaminants in Bird Eggs in the Wadden Sea. Recent Spatial and Temporal Trends. Seabirds at Risk? Effects of Environmental Chemicals on Reproductive Success and Mass Growth of Seabirds at the Wadden Sea in the Mid 1990s. 2004.
No. 19: Wadden Sea Quality Status Report 2004. 2005.
No. 20: Migratory Waterbirds in the Wadden Sea 1980 - 2000. 2005.
No. 21: Coastal Protection and Sea Level Rise. Solutions for sustainable coastal protection. 2005
No. 22: Breeding Birds in the Wadden Sea in 2001. 2006.
No. 23: Seriously Declining Trends in Migratory Waterbirds: Causes-Concerns-Consequences. Proceedings of the International Workshop on 31 August 2006 in Wilhelmshaven, Germany. 2007.
No. 24: Nomination of the Dutch-German Wadden Sea as World Heritage Site. 2008.

Nomination of the Dutch-German Wadden Sea as World Heritage Site

- Volume Two -

ANNEXES

Overview of Annexes

Annex 01

The Outstanding Universal Value of the „Wadden Sea“: A Geological Perspective Flemming, B.W. and Ost, A.P. 2007.

Prof. Dr. B.W. Flemming,
Senckenberg Research Institute

Dr. A.P. Oost
National Institute of Coastal and Marine Management

16 May 2007

Expert opinion

for the Submission of the Dutch-German Wadden Sea for inclusion in the World Heritage List

The Outstanding Universal Value of the „Wadden Sea“:

A Geological Perspective

1. Criterion vii: *“contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance”*

The oldest written record in which reference is made to the Wadden Sea dates back to the 1st Century AD when the Roman historian, Pliny the Elder, after personally visiting the southern North Sea coast in the year 47 AD, described it in his epochal work “Naturalis historia” as an “immeasurable expanse” which is inundated by the sea with forceful currents twice a day and of which it was uncertain whether it formed part of the land or the sea.

The manner in which Pliny describes his experience vividly expresses the fascination and awe which this strange and unique landscape aroused in an uninitiated observer. Is there a better way of expressing the outstanding universal character of a natural environment? The fascination and awe of this environment has persisted for thousands of years now, and it will continue to do so as we ponder the changes which the predicted acceleration in sea-level rise in the course of the next century will impose on it.

The fascination lies in the serene beauty and deceptive peacefulness of the continually changing landscape in the course of a mild and calm summer’s day, when people walk the intertidal flats, making their way to the barrier islands between two high waters. Awesome, indeed, is the experience of a severe winter storm which suddenly and vehemently transforms these placid waters into a turmoil of howling winds, breaking waves and surging water levels which threaten property and life. The written history of the region over the last millennium is full of pitiful records of such destructive inundations. Even as recently as 1953 in the Netherlands and 1962 in Germany, severe storm surges resulted in the loss of many lives, reminding us that - in nature - beauty and hazard often are but two sides of the same coin. The Wadden Sea is rightly being nick-named: *“the flat wilderness”.* It is constantly changing and developing during every tide, and with every storm surge forming a bewildering multitude of unexpected forms of channels, marshes and tidal flats.

To consider this remarkable area as being beautiful is, as always, a judgement in the eye of the beholder. But we, the authors, are, after all these years, still fascinated and smitten by this overwhelming and unique landscape (Fig. 1).

Figure 1: Tidal flats Schleswig-Holstein (Photo. Martin Stock)

2. Criterion viii: *"be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of land forms, or significant geomorphic or physiographic features"*

a) Morphometry: geography and hydrography

The Wadden Sea is located along the continental coastline of the southern and south-eastern North Sea, stretching for about 500 km between Den Helder in the Netherlands (≈ 52°54'N/04°52'E) and Ho Bugt in Denmark (≈ 53°36'N/08°17'E) (Fig. 2). The nomination for the World Heritage List, in this case, restricts itself to the Dutch and German sectors of the Wadden Sea, where special protection statuses have been implemented in the form of National Parks (Germany) or Nature Conservation Areas (Netherlands).

The area of the Wadden Sea as a whole, i.e. the combination of tidal flats, tidal channels and barrier islands, amounts to 9,281 km^2. Of this, 2970 km^2 or 32% are located in the Dutch sector and 5215 km^2 or 56% in the German sector (CWSS 1991; QSR 1993). Together, the Dutch and German sectors of the Wadden Sea thus occupy 88% of the total area. The tides are semidiurnal, the tidal range increasing from 1.4 m in the west (lower mesotidal) to around 4.0 m (lower macrotidal) in the inner German Bight, and back to 2.0 m (upper mesotidal) at the border between Germany and Denmark (and decreasing to 1.5 m near Skallingen). Maximum tidal current velocities in the channels typically reach about 1.5 ms^{-1} at spring tide. Although tidal action dominates the morphologic evolution, wind stresses and waves are important additional driving forces.

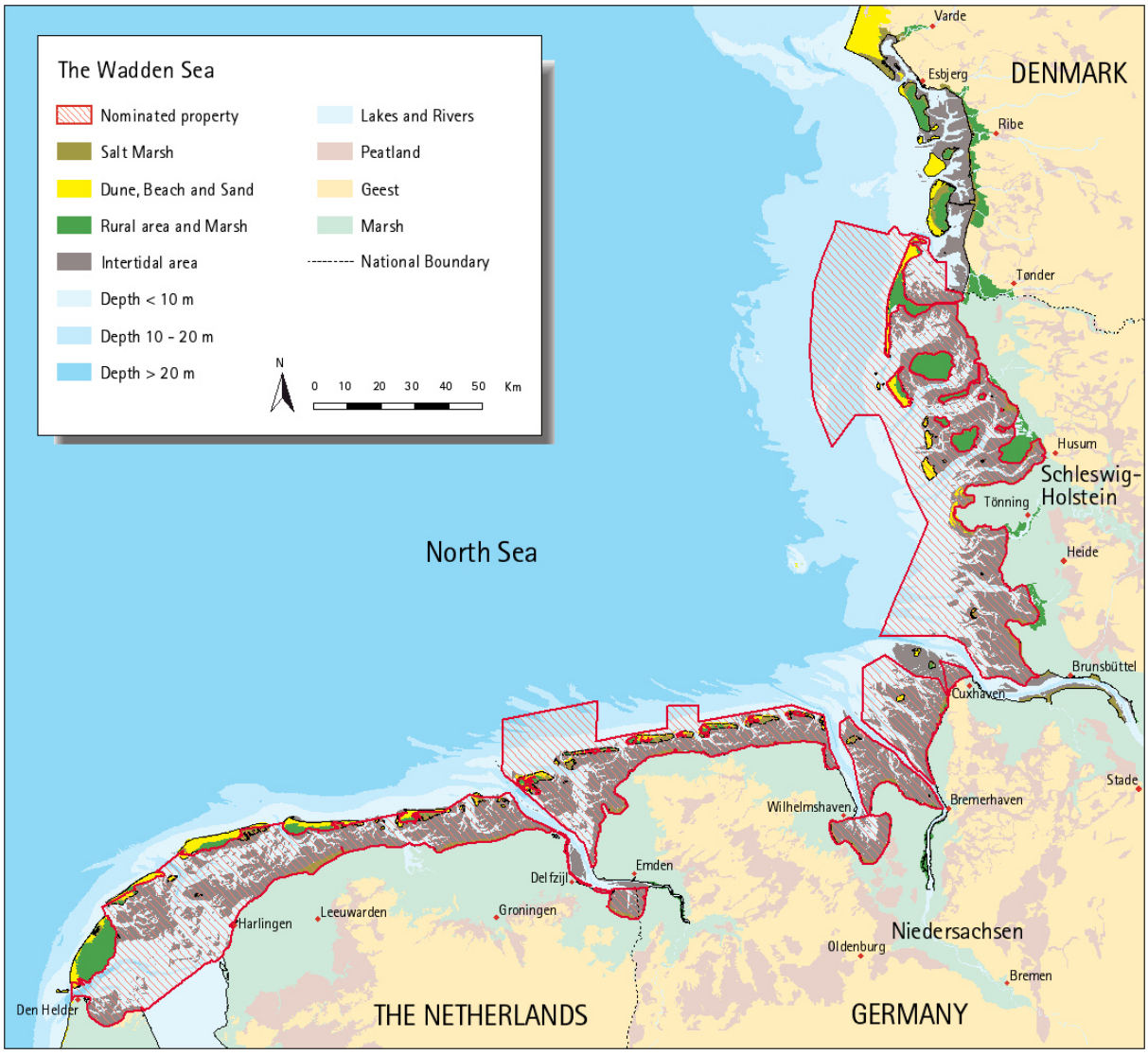


Figure 2. Map of the Wadden Sea and the nominated property.

b) Morphology: a global perspective

The Wadden Sea (German and Dutch sectors) is an outstanding example of the on-going coastal and marine processes in the development of tidal flat deposits, which has led to the formation of the largest temperate zone tidal flat system in the World. According to the Ramsar Convention, the Wadden Sea falls into the wetlands category of estuaries, mangroves and tidal flats. Due to its sheer size, the Wadden Sea tidal flats morphologically and ecologically qualify as a wetland of major value. Searching through the lists of wetlands and considered wetlands (Thorsell et al., 1997, and the list of UNESCO World Heritage) shows that only few areas of the World Heritage list consist (partly) of tidal flats. The Wadden Sea is unique in that it consists entirely of a temperate-climate, sandy-muddy tidal system with only minor river influences fringing the flat and low-lying coastal North Sea Plain of the German Bight. Most of the tidal flat systems on the World heritage lists (both admitted and nominated) are closely related to rivers and their deltas, which, from a morphological and geological point of view, differ strongly from the Wadden Sea situation (e.g. Kakadu National Park in Australia and Sundarbans mangrove forest in Bangladesh), or are quite mountainous (e.g. Gros Morne National Park in Canada). The only tidal flats system, which is to some

extent comparable, is the Banc d'Arguin National Park in Mauritania. This, however, is tropical-subtropical in character.

In principle, intertidal flats and barrier systems can be found worldwide along the shores of most continents and at latitudes from the tropics to the arctic ocean (e.g. Flemming 2002a, 2003). The preconditions are a low-gradient coastal plain and a sufficiently large supply of sediment to at least compensate the rate of sea-level rise. It is sufficient that these conditions existed at some stage during the past 8,000 years or so in order to initiate the formation of such coastal systems. Their survival to this day was then simply a function of the overall sediment budget in the course of continued sea-level rise, coupled with the slope angle of the hinterland.

At closer inspection, a number of unique types of tidal flat and barrier systems can be distinguished on the basis of biological criteria, although the basic physical form is identical in all cases. Thus, tidal flat and barrier systems in tropical and humid-subtropical climates are fringed by extensive mangrove forests (Augustinus 1995), whereas those in arid-subtropical, mediterranean, and higher-latitude climates are characterized by salt marshes (Chapman 1974). In addition, the benthic fauna varies with latitude, tropical and subtropical systems being dominated by a variety of burrowing crabs as indicator species which are progressively replaced by polychaetes and mussels towards higher latitudes (e.g. Reise 2000).

The Wadden Sea belongs to the salt-marsh category of tidal flat and barrier systems. It differs from other systems of this type in that it is the only extensive tidal flat and barrier-island depositional system in the World (it is also Europe's largest coastal tidal marsh and, as far as information is available, one of the biggest temperate climate inter-tidal flat area's with little river influence in the World, excluding mangrove areas). It is dominated by vast expanses of intertidal sediment flats which are exposed at low tide and display a progressively shoreward-fining grain-size gradient (Flemming & Bartholomä 1997). Due to this, and since it was described very early in the 20th century, it is a world-wide unique standard for reference and comparison with other tidal flats in the world. It commences with sand flats in the seaward sections, followed by mixed flats and finally mud flats along the mainland shore (e.g. Dijkema 1989). By contrast, the tidal flats of similar systems in other parts of the world are almost entirely occupied by eel grass meadows (e.g. the Ria Formosa in southern Portugal) or cord-grass marshes (e.g. the east coast of the U.S.A.). This fundamental difference in outward appearance produced by natural vegetation is due to a high supply of fine-grained sediments in the latter cases which has enabled the grass meadows and marshes to encroach entire sand flats by the capture and accretion of mud. Insufficient mud deposition has evidently prevented such basin-wide encroachments by sea grasses or pioneer plants in the case of the Wadden Sea, thereby defining the unique character of its landscape of mainly barren shoals divided by an intricate fractal channel pattern. And unique it is indeed: the Wadden Sea is mentioned in many international textbooks as the example, par excellence, of extensive meso- to macrotidal flats (Zenkovich, 1967; Cronin, 1975; Machatschek, 1973; Reineck & Singh, 1980; Reading, 1981; Schwarz, 1982; Allen, 1984; Stanley, 1989; Eisma, 1998; Reise, 2001).

c) Morphology: the unique details

The integrity of the depositional system composed of a hierarchy of hydro-morphological units is expressed in a coherent lateral sequence. Thus, the basic units of the West and East Frisian Wadden Sea are a series of contiguous tidal basins which are separated from each other by tidal watersheds (Flemming & Davis 1994; Oost & de Boer 1994). These, in turn, are subdivided into a number of characteristic erosional and depositional features such as barrier islands, inlets, ebb-deltas, tidal drainage networks comprising a series of channel hierarchies (gullies), sand flats, mixed flats, mudflats, and salt marshes.

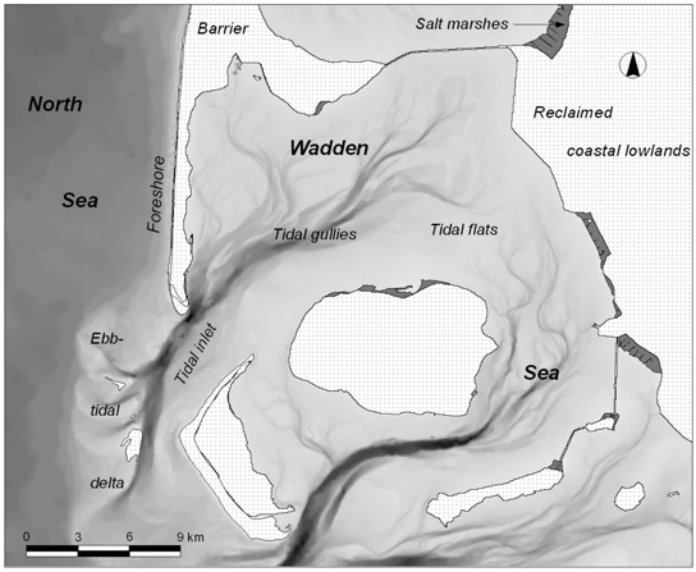


Figure 3: A tidal basin in Schleswig-Holstein (Sylt-Amrum-Föhr) with typical hydro-morphological elements of the Wadden Sea coast (Jacobus Hofstede)

In addition to these structural elements of the barrier islands and tidal basins, the shorefaces of the West and East Frisian barrier island systems consist of several morphodynamic units which, from a geological point of view, are integral parts of the system as a whole: integrity of the interaction is still intact. Thus, the lower shoreface below about 10-12 m of water depth is structured into a series of NW-striking ridges and valleys, so-called shore-face connected ridges, which have spacings of several kilometres and heights of up to 6 m. Such ridge systems have also been reported from other parts of the world, both from barred and non-barred tidal coasts.

The morphology of the upper shorefaces, by contrast, can be subdivided into shore-parallel sand bars typical of many surf zones worldwide, and NE-striking so-called sawtooth bars which occur in water depths between 3 m and 6 m and which have spacings of around 450 m and heights of up to 2 m (Fig. 3). Flemming & Davis (1994) have reinterpreted this ridge and swale topography as representing incised rip-current channels associated with nearshore wave/current generated resonance phenomena. These features appear to be unique to the Dutch and German barrier-island coast.

Figure 4: Typical saw-tooth bar system in front of a barrier island of the East Frisian Wadden Sea.

The macrotidal part of the Wadden Sea lining the inner German Bight lacks barrier islands and hence also ebb-deltas, but otherwise displays similar features as the back-barrier tidal basins, including a number of tidal watersheds. The reason for the absence of barrier islands is the large volume of water which has to be moved into and out of the coastal zone twice a day by the falling and rising tide. This leaves no room for barrier islands, although small ephemeral sand-bank islands may occur from time to time in odd places around mean sea level (Ehlers 1988). In addition, extensive shell beds line many upper sand flats due to the stronger action of storm waves which are less effective in the more protected tidal basins in the rear of the barrier islands.

Locally, unique sedimentary features are present such as naturally open barrier coasts consisting of dunes intersected by small wash-overs (e.g. Ameland). This is unique to NW-Europe.

d) Morphodynamics

As stated above, geological processes are still very active in the development of landforms and continuously lead to the renewal and/or destruction of the landscape by building and/or destroying a variety of geomorphic features. The Wadden Sea's outstanding universal value is mainly due to the strong hydraulic and aeolian dynamics leading to prominent morphological changes on a variety of spatial and temporal scales, from whole groups of inlet systems, influencing each other over many centuries, down to the shifting of a ripple in the order of minutes. Of course, the natural forces not only lead to an autonomous dynamics, but also react to human interventions in the form of land reclamation and dike construction. Morphodynamic adjustments are possible due to the fact that the Wadden Sea system can still react in a natural way to these influences because it is still able to evolve freely in the larger part of the tidal system. On each scale destructive exogenic processes alternate with constructive ones.

Closely interwoven with these dynamics are human activities, man having sought to improve the quality of lifein and around the area for hundreds and even thousands of years. Fisheries, tourism, transport, agriculture and even industry depend on the tides and the changes they bring about in the system, from day to day and from year to year.

e) Morphogenetics

Although we would not press this as a major criterion, the Wadden Sea in its way also represents, in quite a dramatic way, two natural examples of coastal shelf development under conditions of the Holocene sea-level rise. The modern Wadden Sea evolved in the course of coastal evolution since about 8,000 years BP in the wake of the postglacial sea-level rise. Next to sea-level rise itself, a progressively growing tidal range resulting from the increasing water depth in the North Sea basin, the regional storm climate, the sediment budget and, last but not least, an increasing human impact have played prominent roles in its evolution in the course of the last millennium (e.g. Oost & de Boer; Flemming & Davis 1994). However, on the whole, the Wadden Sea has kept its morphological integrity, showing a broad suite of geomorphological features.

As a result of sea-level rise and a mostly deficient sediment budget, the coast retreats in a landward direction while accreting vertically. Today, we distinguish between transgressive and aggradational tidal flat systems in the Dutch and German sectors of the Wadden Sea (cf. Vos & van Kesteren 2000; Flemming 2002b). The lower mesotidal West Frisian (Dutch) and the upper mesotidal East Frisian (German) barrier island systems are transgressive systems. Since not enough sediment is imported from external sources, the systems compensate sea-level rise by moving material from their upper shorefaces to the back-barrier basins. As a consequence, the islands migrate shorewards across their own back-barrier flats in a

process also know as roll-over. The lower macrotidal, non-barred tidal flats of the inner German Bight and southern section of the North Frisian tidal flats, which occasionally display ephemeral supratidal shoals, are essentially aggradational systems, sediment influx from external sources in this case compensating sea-level rise. The northern, barred section up to the border of Denmark is once again transgressive. Form, sequence and scale of these subdivisions are unique to the Wadden Sea.

f) Morphochronology: relevance for the geological inventory

The long-term depositional history has led to the formation of a series of sedimentary deposits which have recorded the development of the Wadden Sea and climate in great detail. Such datable sediments (e.g. Vlieter deposits) and landforms (e.g. SW Texel and the German tidal marsh deposits) can be considered a universally important archive of the Holocene history of sea-level rise, climate, and depositional response.

As stated above, the Wadden Sea represents an outstanding example representing the Holocene development of a sandy coast under conditions of a rising sea level, and, as such, attracted the interest of scientists at an early stage of scientific endeavour. The Wadden Sea is one of the earliest and best studied depositional systems in the world, first scientific investigations dating back to the early years of the last century. Over the years, Dutch, German and Danish geoscientists in particular have established large archives of documentary evidence for tidal processes, stratigraphy, sedimentary structures and sediment distribution patterns in the form of numerous publications, maps, drawings, photographs, slides, seismic profiles, lacquer peels, resin casts, and core logs (see overview of the most important institutes). Together they form an invaluable and unique inventory of the geological character of the Wadden Sea and its genesis, which is unparalleled in the world. Such archives are accessible at a number of marine research stations lining the Wadden Sea coast. In this context, the geological/geomorphological criterion (viii) favouring a nomination of the Wadden Sea for the World Heritage List not only relates to the theme “coastal systems”, but has direct links to other themes such as “stratigraphic sites” and “fossil sites”. As indicated above, the stratigraphic and fossil record of the Wadden Sea form part of the overall geological inventory accumulated in the archives of numerous coastal research institutions.

Country	Location	Institute	Data
Germany	Wilhelmshaven	Senckenberg Institute	Cores, laquer-peels, grain-size data, side-scan sonar images, seismic profiles, geochemical data, biological data, hydrodynamic data
Germany	List on Sylt	Alfred-Wegener-Institute	Biological data, cores, sediment data
Germany	Büsum	Forschungs- und Technologie-zentrum Westküste, University of Kiel	Cores, grain-size data, laquer peels, hydrodynamic data, biological data
Germany	Norderney	NLWK-Forschungsstelle Küste	Historical chart reconstructions, morphological data, hydrodynamic data, biological data
Denmark	Copenhagen	Institute of Geography, University of Copenhagen	Grain-size data, cores, datings,geochemical data
Netherlands	Den Hoorn	Neth. Inst. For Sea Research	Grain-size data, cores, datings, geochemical data
Netherlands	Utrecht	Fac. Of Geosciences, Univ.of Utrecht	Laquer peels, reconstructions, cores, sieve data, hydraulic data
Netherlands	Delft	Technical University Delft	Modelling results
Netherlands	Utrecht	TNO-Bouw en Ondergrond	Cores, datings, seismic profiles

f) Educational value

As in the case of other natural environments, a generally underrated value of the Wadden Sea is its important role in coastal education and research. Wadden Sea research has become synonymous with the geological principle that “the present is the key to the past” (Lyell 1830-33; Geikie 1905). There are few marine areas in the world which are so easily and directly accessible for a hands-on education of scholars and students in the natural sciences. Every year, dozens of school and university classes visit the Wadden Sea for educational purposes, often under the guidance of one of the marine research stations located along the coast. Besides coming from Germany and The Netherlands, regular excursion groups come from afar as Austria and Switzerland. In addition, professional courses are offered regularly to geoscientists employed in governmental, semi-governmental and industrial institutions.

3. Conclusions

The “outstanding universal value” of the Wadden Sea can be summarized as follows:

1) It is a landscape of Outstanding Beauty. It has a long historical record of intensive interactions and responses to human settlement and intervention

2) It is the largest sandy-muddy tidal flat and salt marsh area protected by sandy barrier systems occurring in the temperate zone of the world;

3) Its shoreface shoreline is characterized by morphological features which are at least in part unique to this area: despite human interventions, it has maintained its unique character and morphological integrity;

4) It forms an important natural educational and research laboratory for scholars, students and scientists by illustrating the geological principle that “the present is the key to the past”, with the oldest written record dating back almost 2000 years. Two examples: it forms a comprehensive archive of Holocene coastal evolution, climate change, and depositional responses which is unparalleled in the world;

5) It can be directly linked to other themes of the World Heritage List such as “stratigraphic sites” and “fossil sites”

4. References

Allen, J.R.L., 1984. Sedimentary structures, their character and physical basis. Developments in Sedimentology, no. 30, Elsevier, Amsterdam.

Augustinus, P.G.E.F., 1995. Geomorphology and sedimentology of mangroves. In: Perillo, G.M.E. (ed.), Geomorphology and sedimentology of estuaries. Elsevier Science, Amsterdam, p. 333-357.

Chapman, V.J., 1974. Salt marshes and salt deserts of the world. Cramer, Lehre.

Cronin, L.E., 1975. Estuarine Research, Vol I & II. Academic Press, Inc., New York.

CWSS, 1991. The Wadden Sea. Status and developments in an international perspective. Common Wadden Sea Secretariat, Wilhelmshaven. Geffken Druck, Bremen.

Dijkema, K.S., 1989. Habitats of the Netherlands, German and Danish Wadden Sea. Research Institute for Nature Management, Texel & Veth Foundation, Leiden. J.G. van Beek, Leiden.

Ehlers, J., 1988. Morphodynamics of the Wadden Sea. Balkema, Rotterdam.

Eisma, D., 1998: Intertidal deposits; river mouths, tidal flats and coastal lagoons. CRC Press, Boca Raton, 525 pp.

Flemming, B.W., 2002a. Geographic distribution of muddy coasts. In: Healy, T., Wang, Y & Healy, J.-A. (Eds), Muddy coasts of the world: processes, deposits and function. Elsevier Science, Amsterdam, pp. 99-201.

Flemming, B.W., 2002b. Effects of climate and human interferventions on the evolution of the Wadden Sea depositional system (southern North Sea). In: Wefer, G., Berger, W., Behre, K.-E. & Jansen, E. (eds), Climate Development and history of the North Atlantic realm. Springer, Berlin, p. 399-413.

Flemming, B.W., 2003. Tidal flats. In: Middleton, G.V. (ed.), Encyclopedia of sediments and sedimentary rocks. Kluwer, Dordrecht, p. 734-737.

Flemming, B.W. & Bartholomä, A., 1997. Response of the Wadden Sea to a rising sea level: a predictive empirical model. German J. Hydrogr. 49: 343-353.

Flemming, B.W. & Davis, R.A., Jr., 1994. Holocene evolution, morphodynamics and sedimentology of the Spiekeroog barrier island system (southern North Sea). Senckenbergiana maritima 25: 117-155.

Geikie, A. Sir, 1905. The Founders of Geology. Macmillan & Co., New York.

Lyell, C., 1830-33. Principles of Geology. 3 Volumes. Murray, London.

Machatschek, G., 1973. Geomorphologie, , 10th Ed. B.G. Teubner, Stuttgart.

Oost, A.P. & de Boer, P.L., 1994. Sedimentology and development of barrier islands, ebb-tidal deltas, inlets and backbarrier areas of the Dutch Wadden Sea. Senckenbergiana maritima 25: 65-115.

QSR, 1993. Quality Status Report of the North Sea (QSR). Subregion 10. The Wadden Sea. Common Wadden Sea Secretariat, Wilhelmshaven. Geffken Druck, Bremen.

Reading, H.G., 1981: Sedimentary Environments and Facies, Blackwell Sc. Publ., Oxford.

Reise, K., (Ed.) 2000. Ecological Comparisons of Sedimentary Shores. Ecological Studies 151. Springer-Verlag, Berlin.

Reineck, H.E. & Singh, I.B., 1980: Depositional sedimentary environments, Springer-Verlag, Berlin.

Schwarz, M.L., 1982: The Encyclopedia of beaches and coastal environments. Van Nordstrand Reinhold Company Inc., New York.

Stanley, S.M., 1989: Earth and Life through Time, 2nd Ed., W.H. Freeman & Company, New York.

Thorsell et al., 1997

Vos, P.C. & van Kesteren, W., 2000. The long-term evolution of intertidal mudflats in the northern Netherlands during the Holocene: natural and anthropogenic processes. Continental Shelf Research 20: 1687-1710.

Zenkovich, V.P., 1967. Processes of Coastal Development, Oliver & Boyd, Edinburgh (translated from the Russian).

Authors' addresses

Prof. Dr. B. W. Flemming
Senckenberg Institute
Department of Marine Science
Südstrand 40
D-26382 Wilhelmshaven
Germany
E-mail: bflemming@senckenberg.de

Dr. A. P. Oost
RIKZ
National Institute of Coastal and Marine Management
P. O. Box 207
NL-9750 AE Haren
The Netherlands
E-mail: a.p.oost@rikz.rws.minvenw.nl

Annex 02

The Outstanding Universal Values of the „Wadden Sea“: An Ecological Perspective
Baptist, M.J., Dankers, N. and Smit, C. 2007.

Wageningen IMARES
Institute for Marine Resources & Ecosystem Studies

Location IJmuiden
P.O. Box 68
1970 AB IJmuiden
The Netherlands
Tel.: +31 255 564646
Fax: +31 255 564644

Location Yerseke
P.O. Box 77
4400 AB Yerseke
The Netherlands
Tel.: +31 113 672300
Fax: +31 113 573477

Location Den Helder
P.O. Box 57
1780 AB Den Helder
The Netherlands
Tel.: +31 22 363 88 00
Fax: +31 22 363 06 87

Location Texel
P.O. Box 167
1790 AD Den Burg Texel
The Netherlands
Tel.: +31 222 369700
Fax: +31 222 319235

Internet: www.imares.nl
E-mail: imares@wur.nl

Report
Number: C037/07

The Outstanding Universal Values of the Wadden Sea: an ecological perspective

M.J. Baptist
N. Dankers
C. Smit

Table of Contents

Summary

This report describes the Outstanding Unique Values of the Wadden Sea from an ecological perspective, that is, according to criteria IX and X for the nomination of World Heritage Sites, as defined by the IUCN World Commission on Protected Areas.

The Wadden Sea is an outstanding example of the Holocene development of a sandy coast under conditions of rising sea level and is unique in that it is the largest extensive tidal flat and barrier island depositional system in the World. Its geological and geomorphological features are closely entwined with biophysical processes (biogeomorphology). The biogeomorphological interactions are notably strong and unique on all scales.

The rich and diverse habitats are of outstanding international importance as an essential habitat for of migratory water birds using the East Atlantic Flyway and other migration routes between South Africa, Northeast Canada, and northern Siberia. It is one of the few shallow seas in the Northern Hemisphere with a relatively high production of fish and serves as a nursery area and an essential staging area for species migrating between freshwater and saltwater for spawning and feeding.

The proposed property encompasses all the biophysical and ecosystem processes that characterise a natural and sustainable Wadden Sea. The standards of protection, management and monitoring ensure that the natural Wadden ecosystem, with all its component parts, will continue to evolve naturally and to sustain human uses for the foreseeable future. Man’s use of the natural resources in a sustainable way including traditional resource use is a key to guarantee its integrity for generations to come.

1 Introduction

Since the Esbjerg Wadden Sea Conference in 1991, the nomination of the Wadden Sea as World Heritage Site is being prepared. In recent years progress is high; since 2005 The Netherlands and Germany are working hard on the preparation of a nomination dossier.

The ministry of Agriculture, Nature and Food Quality is co-ordinating the nomination on behalf of the Dutch government. They have requested IMARES, location Texel, to report the Outstanding Universal Values of the Wadden Sea with regard to criteria IX and X. These criteria describe the most important and unique on-going ecological processes and the biodiversity in the nominated site. In addition, the natural integrity of the site should be assessed, the protection and management status should be described and a comparative analysis of other similar sites around the world should be made. This knowledge subsequently feeds into Chapter 3 of the nomination dossier and the complete text of this report will be incorporated as an appendix to the dossier.

This report consists of two chapters that refer to the criteria IX and X as defined by the IUCN World Commission on Protected Areas, and a list of references.

2 Criterion ix

"be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals"

Physical processes shaping shallow coastal zones can be found anywhere in the world. The Wadden Sea, however, is of a special kind. It is the only non-tropical extensive tidal flat and barrier-island depositional system in the World (see criterion viii) (Wolff, 1983). Very characteristic are the non-fixed, and therefore 'walking islands' or considerable parts of islands. Of a special kind are the biogenic structures such as reefs of oysters, mussels or tube-building worms that affect the morphology as 'ecosystem engineers'.
Its sheer size gives rise to a multitude of biophysical and ecological processes that cannot be found within one system anywhere else. The Wadden Sea is characterized by a *complete system of gullies and flats*, i.e. an outer delta, a tidal inlet and a basin with ebb- and flood gullies that end in very small '*prielen'*. The completeness of this system, which is found in a fractal manner, is extraordinary; see Figs. 1, 2 and 3. The tidal-channel systems can be regarded as 'statistical self-similar fractal'networks and the similarity of the channel systems points to a self-organising nature (Cleveringa & Oost, 1999). On smaller scales, fractal patterns are also found in the muddy deposits. Moreover, the spatial distribution of intertidal benthic communities shows fractal patterns as well. Intertidal mussel beds in the Wadden Sea, for example, show a spatial self-organisation (Van de Koppel et al., 2005). Interestingly, the origin of fractal patterns in ecosystems can have seven different explanations (Halley et al., 2004). For benthic communities two possible explanations are likely: The first is that a fractal distribution of abiotic factors presents a template upon which organisms and communities operate. The second is that a fractal spatial pattern is a result of community self-organisation which is transformed in spatial structures under environmental influences (Azovsky et al. 2000). A final answer has not been given yet. It is known that complex spatial patterns affect ecosystem processes such as resource utilization, movement of organisms and redistribution of nutrients, and that they support more complex ecological communities (Turner, 1989; Levin, 1992). Research focusing on the linkages between scales, ecological processes and complexity is a central problem in biology. The Wadden Sea is a prime example.

An ecosystem can only function in an optimal state when all physical, chemical, geomorphological and biological processes can operate in an undisturbed and coherent manner and in a functional relationship. When a system is large enough and many parts are relatively undisturbed there is a big chance that this will be the case for the system as a whole. The Wadden Sea fulfills this criterion.

Fig. 1. Pattern of gullies in the Eijerlandse inlet between Texel and Vlieland (scale 30x30 km)

Fig. 2. Pattern of 'prielen' on a tidal flat (scale 200 x 200 m) (Photo courtesy Martin de Jong, IMARES).

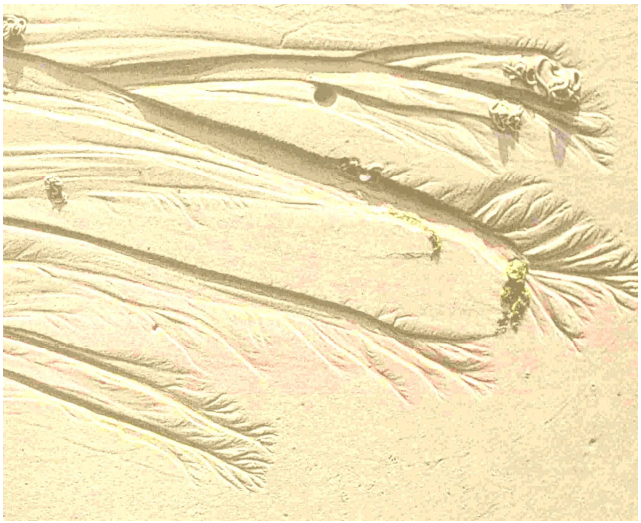


Fig. 3. Pattern of very small ' prielen' on a tidal flat (scale 1x1 m) (Copyright Waddenvereniging).

The Wadden Sea is a relatively young system that has developed because of sea-level rise in the past 6000 years (Beets & Van der Spek, 2000). It has a *variety of flat types*, ranging from coarse sand in the inlet, up to silt and mud along the inner margins and at the *tidal divide* behind the barrier islands. Some flats emerge only shortly, others only inundate during storm floods. In an interplay of physical, ecological and biological processes specific structures or even landscape size forms develop. On the shore, where vegetation can grow, *coastal dunes* form in the more exposed, sandy parts and *saltmarshes* in the sheltered, muddy parts. In the tidal flat itself, extremely high densities of specific animal species influence the system in such a way that they form biogenic structures such as mussel beds, oyster and *Sabellaria* reefs. To our knowledge, such biogenic reefs in non-tropical waters have not been listed before in World Heritage Nominations.

The whole range of these geomorphological and biological structures and communities occur in a functional relationship, making the Wadden Sea a 'complete' ecosystem. This means that functional relationships are found on all spatial and temporal scales in coherence with each other. Its completeness and size make the Wadden Sea an outstanding and unique non-tropical ecosystem. Furthermore, due to the estuarine influence of the Rhine (although through sluices) and Eems, Weser, Elbe, Eider and Varde Aa one finds density-driven currents, a turbidity maximum and a biological richness including migratory fish and brackish species.

Physical drivers, such as tides, wind, currents, waves, and biological processes, such as competition for resources, occurring in a large area have resulted in the richness of geomorphological and biogenic structures found. Due to the undisturbed presence of these processes, structures are not only conserved, but there are also rejuvenation cycles, creating new structures and breaking down old structures. Examples are the dunes and saltmarshes that can be found in all stages of succession, and structured mussel banks, which are formed by a combination of growth and food depletion from the overlying water (Van de Koppel et al., 2005).

As a shallow sea, the benthic-pelagic coupling is notably strong, and the primary and secondary production are high. This production forms a foundation to the intricate food web that ultimately results in an important nursery area for fish, a foraging and resting habitat for seals, and a foraging habitat for waders, which will be discussed later in more detail. These functions of the Wadden Sea, and specifically its importance as a nursery area, were the main arguments in the 1970s not to embank this system, and it still serves as a prime example of the change in attitude in large scale conservation of ecosystems on landscape scale. In the US at that time the emphasis was laid on the function of saltmarshes in production and export of organic matter and nutrients to the coastal ecosystem. In the case of the Wadden Sea the emphasis was more on its specific value in combination with the services to surrounding ecosystems.
The Wadden Sea has an intrinsic relationship with the North Sea. The North Sea is one of the few shallow and relatively sheltered seas in the Northern Hemisphere with a relatively high production of fish. The combination of a large, shallow and highly productive sea combined with a system like the Wadden Sea is unique on a world scale (Wolff, 1983).

a) Primary and secondary production
One of the outstanding features of the Wadden Sea is that the in situ primary production is to a large extent the result of benthic production. In coastal zones in general, the phytoplankton production dominates, but the Wadden Sea is unique in its enormous surface area of emerging tidal flats that host high densities of microphytobenthos. The contribution of microphytobenthos to the primary production is about as high as the primary production by planktonic algae (Cadée & Hegeman, 1974a and b; Asmus et al., 1998). The gross primary production by microphytobenthos, which reaches values of over 1000 mgC m^{-2} d^{-1}, is the highest in the world for locations north of 42^{o} latitude (MacIntyre et al., 1996, Table 4). Next to the in situ production there is a large net import of algae produced in the coastal regions of the North Sea.
Because of the abundant supply of algae, the secondary production is large, as well. The sandy and muddy bottoms host a variety of macrozoobenthic herbivores, which can reach locally high densities. Not only phytoplankton, but also benthic diatoms are an important food source for filterfeeding bivalves. Suspended microphytobenthos may represent up to

50 % of the microalgae in the water column and thus of the food of filterfeeders (De Jonge, 1985, Fig. 7).

b) Biogenic structures and biogeomorphology
Due to the shallowness of the area and the fuzzy boundaries between land and sea, there is a strong interaction between biota and geomorphological processes, i.e. biogeomorphology (Baptist, 2005; Stallins, 2006).
The geomorphological influence on biota is in its most direct form the influence on habitats of flora and fauna. The Wadden Sea morphology and geomorphological processes therein define gradients between high and low, wet and dry and sedimentation and erosion. These gradients and the processes that cause them are determinative for gradients in grain size of the sediment, nutrient levels, organic matter levels and moisture. Plants and animals are tuned to specific conditions and will therefore be abundant in specific locations, i.e. there habitats. In the coarse grained and dynamic sediments a large abundance of specific polychaete worms (*Scolelepis squamata*) occurs with densities of up to 300 grams/m². In the more sheltered parts the flats are abundant with worms and cockles. Mussel beds are recovering after closure of fisheries, and in dense beds of shellfish, biomass may reach values of more than 50 kg per m².
Conversely, the biological influence on geomorphological processes is the influence of biota to create, maintain or transform their own geomorphological surroundings. This is demonstrated by the influence of vegetation on the hydraulic resistance, erodibility and sedimentation, or by the influence of fauna on sediment characteristics through bioturbation and biostabilization.

The Wadden Sea forms an outstanding example of biogeomorphological interactions (see Box). Important in this respect is that the Wadden Sea has many examples in which the timescale for geomorphological changes coincides with the timescale for biological changes. This results in mutually interacting processes. Unlike other areas in the world, landscape processes are not dominated by geological timescales nor do biological processes dominate landscape features. This means that the constantly changing landscape requires adaptation of organisms and at the same time that organisms affect their environment as 'ecosystem engineers'. Excellent and broad scale examples of these biogeomorphological interactions can be found in the dunes, the tidal flats and the saltmarshes. Of particular interest are for example the intertidal mussel beds. These form a biogenic structure that has considerable influence on the morphology of the tidal flats; they stabilize the sediment, preventing it from erosion and actively accrete silt. The numerous macrobenthic species can have an opposite effect. Their constant reworking of the sediment (bioturbation) makes the bed more susceptible to erosion. Saltmarshes form another example in which the capturing of silt increases the bed level, which leads to changes in vegetation composition and subsequent changes in sedimentation rates.

The important ecosystem types in the Wadden Sea (ecotopes or habitats) are those which are formed and maintained by an interplay of physical and biological processes. This interplay is essentially an interaction of on-going geological processes in the development of landforms and on-going ecological and biological processes. This feature cannot be described under criterion viii or criterion ix separately.

Biogeomorphology in the Wadden Sea

Physical processes in the Wadden Sea and its estuaries, such as flow, tides and waves, are responsible for the mixing of the water column, the transport of sediment and the transport of nutrients and organisms. Sandy coasts with small tidal amplitude develop into a system of barrier-islands with intertidal flats between the islands and the mainland. The tidal currents together with wind and wave action are responsible for the maintenance of gullies and tidal flats. The Wadden Sea system is characterized by complete gully system. That means a tidal inlet, ebb and flood systems and main channels, which branch into small gullies and creeks in sandy or silty areas or salt marshes. Within the Wadden Sea system there is a diversity of tidal flats with sediment of different silt content and different exposure times.

Biological processes both respond to and affect pattern diversity, geomorphological processes and sediment characteristics. Typical structures of biogenic origin can develop

on the tidal flats, such as oyster and mussel beds, reefs of tube building polychaetes, eelgrass fields, burrows and tubes of digging polychaetes or mats of microphytobenthos. Biogenic habitat transformations result (Reise, 2002). Reefs of suspension feeders increase bed roughness and actively filter suspended particles, accumulating these in the bed and leading to a raised and stabilized bed. Eelgrass meadows slow down flow, protect the bed from erosion and trap suspended particles, raising the bed. The reworking of the bed by infauna changes the sedimentary budget and composition, and making it more susceptible to erosion. Mats of microphytobenthos have a seasonal effect on bed height and silt content through excretion of polymeric substances gluing the bed particles together and thus making it more resistant to erosion. In quiet places under favourable conditions salt tolerant pioneer vegetation may develop on tidal flats. When the pioneer vegetation is succeeded by a vegetation of the next successional stage, the young, low-lying salt marsh will maintain itself by enhancing sedimentation. In a period with sea-level rise, the marsh will grow higher but if the tidal flat lags behind, cliff formation along the marsh occurs. Subsequently, the marsh will erode until new vegetation will develop on the bare gently sloping tidal flat.

All these biogeomorphological interactions can be found in and on the tidal flats of the Wadden Sea. The constantly changing conditions, the multitude of feedback systems and the very wide variety in scales make it a unique ecosystem.

Because the Wadden Sea contains many different types of islands, sheltered and exposed dunes and subsequent sheltered and exposed types of saltmarsh and green beaches there also is a great variety in vegetation types and communities. Many textbooks refer to the Wadden Sea as a strong example when describing different vegetation types. An excellent overview of vegetation types is found in Dijkema & Wolff (1983). Dijkema et al. (1984) investigated all saltmarshes along the European coasts and concluded that those bordering the Wadden Sea are of eminent importance because of their size and completeness.

Dense concentrations of animals, whether forming biogenic structures or not, may form specific communities. More than 125 years ago the community of an oyster reef in the Wadden Sea was described and the term '*BIOCOENOSIS*' was introduced (Möbius, 1877). This term is now widely used in the ecological literature, and the present day mussel beds and oyster reefs can still be regarded as prime examples.

Integrity and/or authenticity
The Wadden Sea has sufficient size to contain a functional coherence of ecosystem elements. Morphodynamic processes have relative freedom to occur. Biological processes depending on, and affecting geomorphology can be found on many scale levels, from seasonal microphytobenthos mats gluing the sediment together to saltmarshes raising the sediment level and growing with sea level rise. Anthropogenic influences are well regulated, a set of ecotargets is internationally agreed on (Esbjerg declaration) and monitored to safeguard the integrity. Rehabilitation measures are being carried out, for example on mussel beds. Up to the seventies mussel beds covered extensive parts of the tidal flats, filtering the water above and producing faecal pellets that sink to the bed. As a result, these beds capture fine sediments and prevent erosion. Due to over fishing these beds have almost disappeared, but rehabilitation measures seem to work out well (Dankers et al., 2003, 2004., De Vlas et al., 2005).

The present status of the system is well described by Essink et al. (2005) in the most recent Quality Status Report (QSR), and possible threats are given by Nordheim et al (1996) and Ssymanck & Dankers (1996).

Protection and management
The protection status of the Wadden Sea is sufficient to keep the system in its present state, but more conservation efforts are required in order to reach a favorable conservation status as required by the EU- Bird and Habitat directives. These measures are laid down in many agreements and European and national legislation.

Comparative analysis
The Wadden Sea forms an outstanding example of biogeomorphological interactions on all scale levels. The features of shallow productive mud flats, strong benthic-pelagic coupling and interactions between biology and morphology can be found in other estuaries, but not on the scale and the completeness of the Wadden Sea. The closest resemblance has the Banc d'Arguin in Mauritania. Its total size is larger than the Wadden Sea (12,000 km^2), but half of it is terrestrial and it has much less intertidal area (540 km^2). Furthermore, it is located in an entirely different biogeographical region, it does not have barrier islands and has very sheltered regions. In fact, the comparative analysis in the nomination dossier of the Parc national du Banc d'Arguin does not even consider the Wadden Sea as a comparable area.

There is no similar area in northern latitudes to be found. The Ria Formosa is of a much smaller size, not containing similar dune and saltmarsh systems, while there also is a lack of very silty parts. The barrier systems of North/South Carolina and Georgia (US East coast) have similar geomorphological characteristics but are very different from an ecological point of view because the intertidal flats are covered with *Spartina*, while these in the Wadden Sea are bare or partly covered by sea grasses (*Zostera* sp.). The barrier systems of Louisiana can not be compared because they have such a small tidal range that the majority of the sandbanks are permanently covered by the sea.

3 Criterion x

"contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation"

The Wadden Sea is extremely rich in environmental gradients and transitional zones, yielding many different (micro)habitats. This forms the basis for exceptional species diversity. The saltmarshes host about 2,300 species of flora and fauna. The marine and brackish areas count even 2,500 species. As a result of the many different microhabitats, there is a high degree of ecological specialization.

a) Fish
The shallow environment of the Wadden Sea is of vital importance to the reproduction of many fish species (Berghahn, 1987). The Dutch Wadden Sea is used by 13 species that are hatched in the North Sea and use the Wadden Sea as nursery area, the Marine Juvenile species. An additional 17 species are Estuarine Resident; they live here during their entire life cycle. Furthermore, there are 10 species that use the Wadden Sea seasonally in search for food, 9 species that migrate through the Wadden Sea, 2 freshwater species and in total 45 marine visitors have been caught since 1960 (Hovenkamp & Van der Veer, 1993).
The Wadden Sea is, therefore, indispensable for a much wider area comprising large parts of the North Sea. Since there is an active exchange of fish between the North Sea and the Wadden Sea, population dynamics of North Sea fish species can drive ecological processes in the Wadden Sea.
The Wadden Sea is important to migratory fish. It gives an open connection between large rivers, such as Eems & Elbe, and the North Sea. The following fish species are (or were in case of the sturgeon) found in the Wadden Sea and are listed on the IUCN Red List:

Species	*Common name*	*IUCN Red List status*
Acipenser sturio	Common sturgeon	CR A2d
Alosa alosa	Allis shad	DD
Alosa fallax	Twait shad	DD
Coregonus oxyrinchus	Houting	DD
Lampetra fluviatilis	River lamprey	LR/nt
Raja clavata	Thornback skate	LR/nt

Restoration of smooth salinity gradients in open connections with (small) rivers might improve conditions for these migratory species.

b) Marine mammals
On top of the benthic and pelagic food chain, marine mammals depend on the large productivity of the Wadden Sea. Four species are inhabitants of the Wadden Sea: Harbour seal (or Common seal), Grey seal, Harbour porpoise and Bottlenose dolphin.

Harbour seals in Europe belong to a distinct sub-species (*Phoca vitulina vitulina*) which is found mainly in UK, Icelandic, Norwegian and Wadden Sea waters. The international Wadden Sea holds approximately 20% of the world-population (some 20,000 individuals). Samples from seals in Northern Ireland, the west and east coasts of Scotland, the east coast of England, the Dutch and German Wadden Sea, the Kattegat/Skagerrak, Norway, the Baltic Sea and Iceland have been subjected to genetic analysis. This analysis suggested that there are genetically distinct common seal populations in European waters (Goodman, 1998). There is probably very little movement of breeding animals between these populations.
A unique feature of the Wadden Sea Harbour seals is that they rely on the Wadden Sea tidal sandflats for resting. Their resting habitat disappears during high tide and therefore, their behaviour is completely adapted to these conditions. There's one other location

where this is found, The Wash (UK), however an insignificant number of seals are situated here. All other Harbour seal habitats consist of rocky shores.

Grey seals (*Halichoerus grypus*) are found across the North Atlantic Ocean and in the Baltic Sea. There are three regional populations. One in the Northwestern Atlantic; in Canada, on Nova Scotia and the Gulf of StLawrence, one in the Northeastern Atlantic; Iceland, UK, Wadden Sea, and a Baltic population.
The number of Grey seals in the Wadden Sea is steadily increasing. In 2006, a number of 1786 animals have been observed in the Dutch Wadden Sea (Reijnders, pers. comm.). This is however, a small percentage compared to the number of Grey seals in British waters, which counts approximately 120,000 individuals.

Harbour Porpoise (*Phocoena phocoena*) is a typical coastal species. It is mainly found in a wide area of the North Atlantic (including North Sea) and North Pacific. The most important calving and nursing site of the central North Sea is off the coast of the Wadden islands Sylt and Amrun (Sonntag et al., 1999). The Wadden Sea itself is not essential to the survival of this species, but is extensively used around March, when Harbour porpoise hunts for adult Herring that enters the Wadden Sea (Leopold, pers. comm.). The numbers of sightings along the Dutch coast are increasing significantly from 2000 onwards and porpoises are regularly observed in the Wadden Sea (Camphuysen & Peet, 2006).

Species	*Common name*	*IUCN Red List status*
Phocoena phocoena	Harbour porpoise	VU A1cd

Bottlenose dolphin (*Tursiops truncates*) is a typical coastal species as well. They reside along the southern North Sea coasts and were frequent visitors of the Wadden Sea until the Zuiderzee was closed off (1932). In recent years their presence is infrequent, although in 2004 large groups (tens to hundreds) were seen entering and leaving the Wadden Sea through the Marsdiep at Texel (Camphuysen & Peet, 2006).

Species	*Common name*	*IUCN Red List status*
Tursiops truncates	Bottlenose dolphin	DD

c) Migratory birds
The value of the Wadden Sea to migratory birds is eminent. A maximum of some 6.1 million birds are present in the international Wadden Sea *at the same time* (Blew & Südbeck, 2005). Each year on average 10 to 12 million birds migrate back and forth between their breeding grounds in Siberia, Scandinavia, Greenland and North-East Canada and their wintering grounds in Europe and Africa. These birds use the Wadden Sea for a short stay, as a major stop-over site for refueling or as a wintering area (Meltofte et al., 1994).

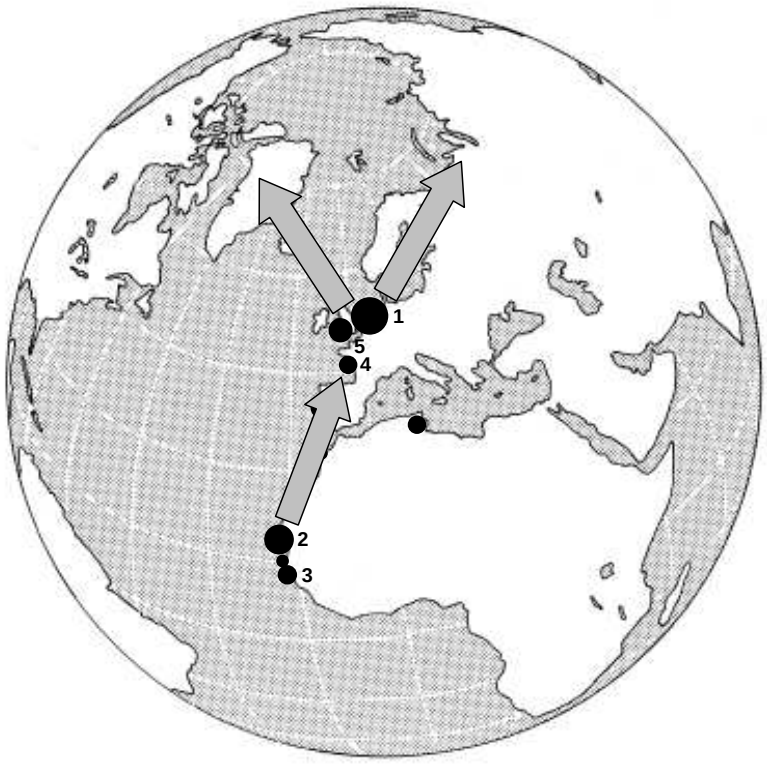


Figure 4. Important areas for waders along the East-Atlantic flyway. (1) Wadden Sea (2) Banc d'Arguin, Mauritania, (3) Bijagos Archipelago, Guinea-Bissau, (4) French tidal flats, (5) UK estuaries.

Fig. 4 shows the important areas for waders along the East-Atlantic flyway. The southernmost area that is important for waders is the Bijagos Archipelago in Guinea-Bissau. This is an estuarine area with tidal flats and mangroves, covering 1570 km^2 (Zwarts, 1988). More to the north lies the Banc d'Arguin in Mauritania. This has a rather small intertidal area of approximately 535 km^2, including sebkhas and small areas covered with *Spartina* and mangroves (Hagemeijer & Smit, 2004). This is considerably smaller than the Wadden Sea, which has a total size of 9,500 km^2 of which 4,534 km^2 consists of intertidal flats (Meltofte et al. 2004). The Banc d'Arguin is the most important wintering ground and most birds that migrate to their breeding grounds up north make a stop-over in the Wadden Sea, especially those breeding in Scandinavia and on the Siberian tundras. The Wadden Sea itself is an irreplaceable stop-over on the migratory flyway. Apart from the Wadden Sea, various small Moroccan, Portuguese and French tidal flats may serve a role as "pit stop", especially during unfavourable weather conditions (northern wind) and so does the southwest of the Netherlands, but these are of insufficient size to host the whole population for an extended period of time (Smit & Piersma, 1989, Reneerkens et al., 2005).

The importance for migrating birds is of outstanding universal value from the point of view of conservation. For at least 52 geographically distinct populations of 41 bird species, more than 1% of the biogeographical population occur in the Wadden Sea. All in all, this means that a very special international responsibility of the Wadden Sea has to be stated for these populations and species (Meltofte et al., 1994; Rasmussen et al., 1996).

Meltofte et al. (1994) give an excellent overview of the international importance[1] of the Wadden Sea for birds:

Gulls and terns

Among gulls and terns, the Wadden Sea is of international importance for at least nine populations. Most of these also breed in internationally important numbers.

Ducks and geese

An estimated 2.0-2.5 million ducks and geese visit the Wadden Sea during the year. For 11 populations of waterfowl the area is of international importance. Almost the entire population of "Russian" Barnacle Goose *Branta leucopsis* and Dark-bellied Brent Goose *Branta b. bernicla* use the Wadden Sea. Largest waterfowl numbers occur in late autumn, when more than 1 million are regularly present. Wigeon *Anas penelope*, Shelduck *Tadorna tadorna* and Eider *Somateria mollissima* are most numerous. For the two latter species, the Wadden Sea is the most important moulting area for the north European populations.

Waders

An estimated 6-7 million waders visit the Wadden Sea each year. For about 30 populations of West Palearctic and Nearctic waders (20 species of coastal as well as inland waders) the area is of international importance, and in 12 of these more than half of the population occurs in the Wadden Sea. Almost the entire flyway populations of Grey Plover *Pluvialis squatarola*, Siberian Knot *Calidris c. canutus*, West Palearctic Dunlin *Calidris a. alpina* and Bar-tailed Godwit *Limosa lapponnica* visit the area each year.

Almost the entire population of the Dark-bellied Brent Goose and the entire North-European population of Dunlin use the Wadden Sea during several periods of their annual cycle (Blew & Südbeck, 2005). In addition, the Wadden Sea and the coastal zone of the adjacent North Sea are used by high numbers of moulting and feeding common eider and support the entire Northwest-European population of Common Shelduck during moult in summer. Without the Wadden Sea their populations would suffer heavily.

Moreover, for in total 34 species, the nutritious tidal flats and salt marshes are an indispensable stopping place on their migration route, or form their primary wintering or moulting habitat. Therefore the Wadden Sea can be considered essential for the existence of these species. A severe deterioration of the Wadden Sea implies a biodiversity loss on a world-wide scale. This applies primarily for the following 34 species (Blew & Südbeck, 2005):

1. Great Cormorant
2. Eurasian Spoonbill
3. Dark-bellied Brent Goose
4. Barnacle Goose
5. Common Shelduck
6. Eurasian Wigeon
7. Common Teal
8. Mallard
9. Northern Pintail
10. Northern Shoveler
11. Common Eider
12. Eurasian Oystercatcher
13. Pied Avocet
14. Great Ringed Plover
15. Kentish Plover
16. Eurasian Golden Plover
17. Grey Plover
18. Northern Lapwing
19. Red Knot
20. Sanderling
21. Curlew Sandpiper
22. Dunlin
23. Ruff
24. Whimbrel
25. Bar-tailed Godwit
26. Eurasian Curlew
27. Spotted Redshank
28. Common Redshank
29. Common Greenshank
30. Ruddy Turnstone
31. Black-headed Gull
32. Common Gull
33. Herring Gull
34. Great Black-backed Gull

[1] An area is considered internationally important when more than 1% of a biogeographical population frequently is present in that area. The term internationally important originates from the Ramsar Convention and has been widely used since then in many international agreements and publications.

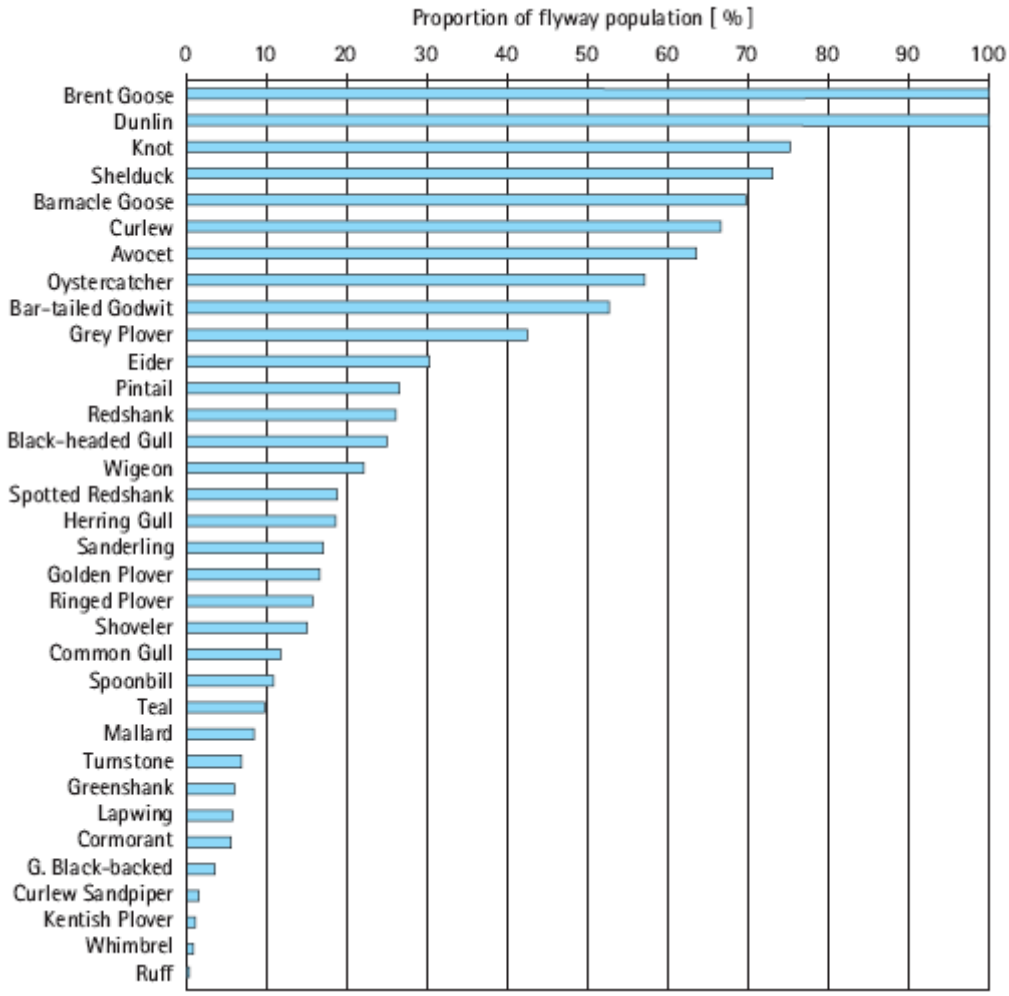


Figure 5. Maximum estimated numbers of migratory birds between 1992-2000 given as proportion of flyway populations (Wetlands International, 2002) for the entire Wadden Sea. From: Blew & Südbeck (2005).

d) Breeding birds

21 breeding bird species occur in the Wadden Sea at internationally important levels (at least 1% of the NW-European population). Many of these species (9) are also included in Annex I of the EC Birds Directive and deserve as such special protection. Another four species breed in rather low numbers in the Wadden Sea, but are included in Annex I as well (Ruff *Philomachus pugnax*, Little Gull *Larus minutus*, Mediterranean Gull *Larus melanocephalus* and Short-eared Owl *Asio flammeus*). In an international context, the Wadden Sea is a core breeding area for Eurasian Spoonbill, Avocet, Gull-billed Tern and Sandwich Tern. For each of these species more than 25% of the NW-European population breeds in the Wadden Sea area (Koffijberg et al., 2006), Figure 6.

One of the breeding birds, the Black-tailed godwit, is found on the IUCN Red List. It has 4% of the NW-European population in the Wadden Sea, mainly the Dutch part.

Species	*Common name*	*IUCN Red List status*
Limosa limosa	Black-tailed Godwit	NT

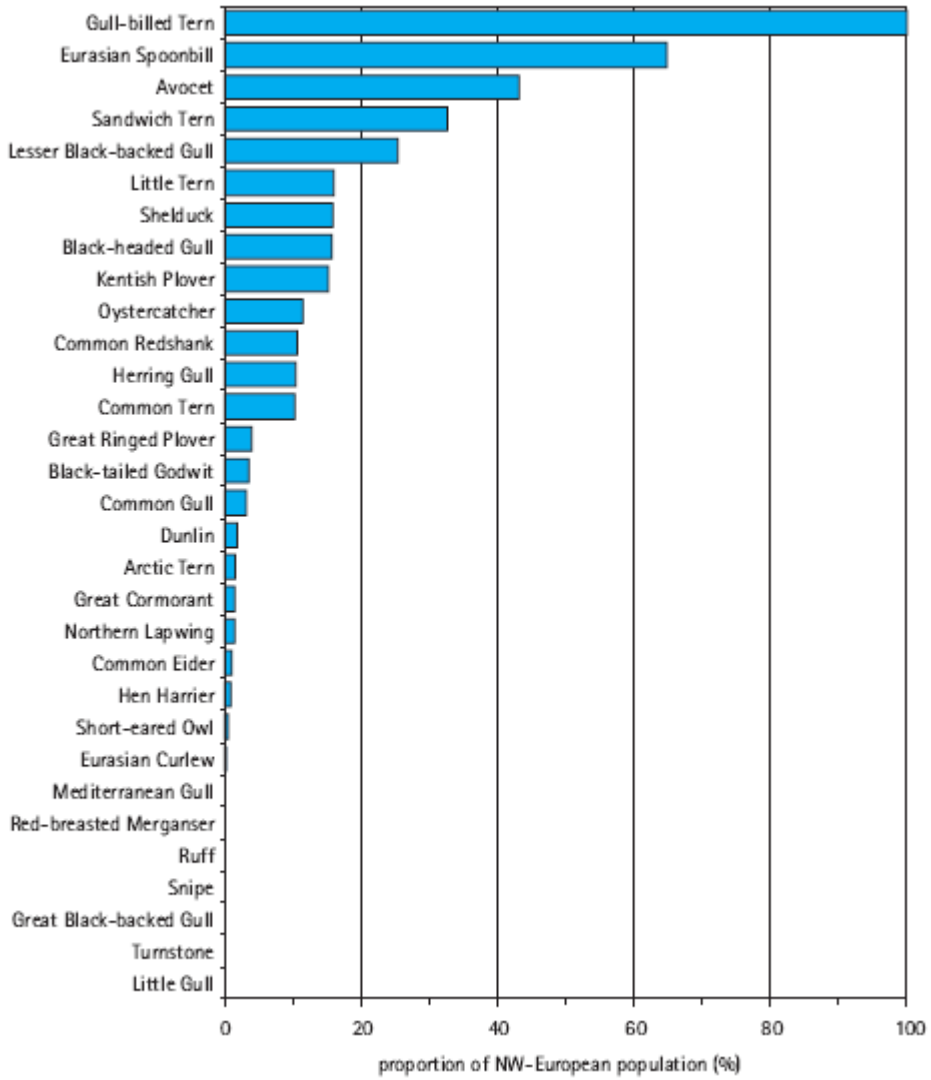


Figure 6. Comparison of breeding bird populations in the Wadden Sea in 2001 with NW-European population sizes given by BirdLife International (2004) and Thorup (2006, waders only). From: Koffijberg et al. (2006).

Integrity and/or authenticity

Although bird migration is a global natural phenomenon that cannot be associated to a single site, the Wadden Sea is a vital and irreplaceable stepping stone that is considered a critically important 'mega-site' for bird migration. It is not just one of several stopover sites on the East-Atlantic flyway, but it is *the* essential stopover.

Because of the size, the length and the different conservation regimes most of the natural ecotopes of a barrier island saltmarsh and tidal flat system still exist. Especially the mutual dependency of ecotopes and completeness of an entire system can be found in the Wadden Sea. The quality of the area for migrating birds also is partly the result of the large size, which makes it easier to flee to other parts of the area when locally the conditions are less optimal.

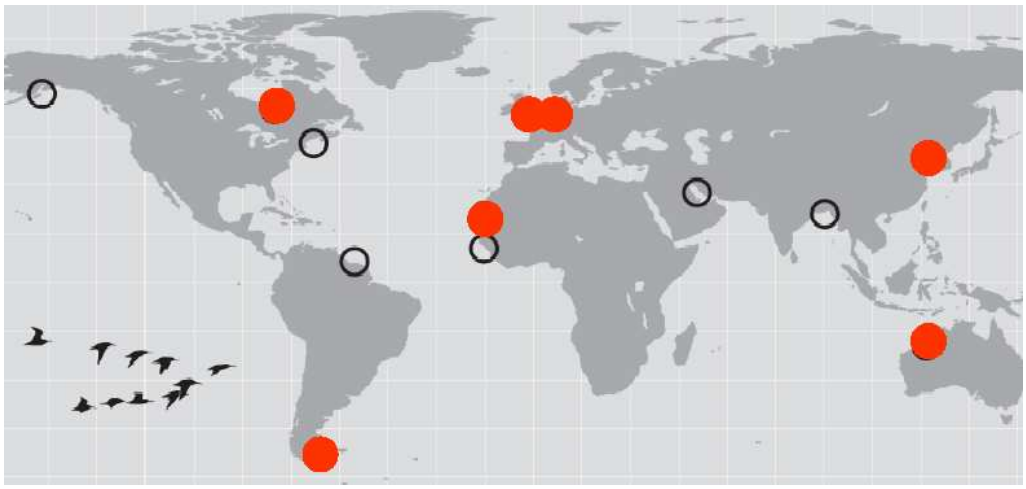


Figure 7. Important and large wadden areas, filled circles represent areas where shellfish are an important food source (after Van de Kam et al., 1999).

Protection and management
The protection status of the Wadden Sea is laid down in many agreements and European and national legislation.

Comparative analysis
The Wadden Sea belongs to the largest wadden areas in the world. Although wadden areas occur in more locations around the world (Fig. 6), most of them have a distinctly different character.

The international Wadden Sea is, with 490,000 ha of tidal flats, by far the largest of Europe. It is 16 times larger than the second largest (Morecambe Bay, UK, 33,700 ha). Its area is even one and a half times larger than all the intertidal areas in the 155 British estuaries together. Apart from Morecambe Bay, the larger ones are the Wash (29,800 ha), the Solway Firth (24,600 ha), the Severn (16,900 ha), the Dee (13,000 ha), the Humber (13,500 ha) and the Thames (totalling 25,500 ha of smaller areas). Other large wadden areas in more or less temperate regions can be found along the East coast of Canada (Bay of Fundy, Hudson Bay), in Alaska (Copper River Delta), in East Asia (Yellow Sea), and West Asia (Persian Gulf). In tropical regions large areas are found in West-Africa (Guinea Bissau and Mauritania), South-East Asia (China, Vietnam and Irian Jaya), Northwest Australia and in Suriname (Van de Kam et al., 1999).

The Wadden Sea climate cannot be compared to those in tropical or arctic regions. Apart from that, the character of the Wadden Sea, having a tidal flat and barrier-island system, is of outstanding universal value.

4 References

Asmus, R., M.H. Jensen, D. Murphy & R. Dörffer. 1998. Primary production of the microphytobenthos, phytoplankton and the annual yield of macrophytic biomass in the Sylt-Rømø Wadden Sea (In German, English abstract). In: C. Gätje & K. Reise (Eds.) Ökosystem Wattenmeer – Austausch-, Transport- und Stoffumwandlungsprozesse. Springer-Verlag Berlin Heidelberg, pp. 367-391.

Azovsky, A.I., M.V. Chertoprood, N.V. Kucheruk, P.V. Rybnikov & F.V. Sapozhnikov, 2000. Fractal properties of spatial distribution of intertidal benthic communities. Marine Biology 136: 581-590. DOI 10.1007/s002270050718.

Bakker, J.P., J. Bunje, K. Dijkema, J. Frikke, N. Heckler, B. Kers, P. Körber, J. Kohlus & M. Stock, 2005. Salt Marshes. In: Essink, K. Dettmann, C. Farke, H. Laursen, K. Lüerszen, G. Marencic, H & Wiersinga, W. (Eds.). Wadden Sea Quality Status Report 2004. Wadden Sea Ecosystem No. 19 Trilateral Monitoring and Assessment Group, Common Wadden Sea Secretariat, Wilhelmshaven, Germany. pp. 163-179.

Baptist, M.J., 2005. Biogeomorphology. In: Schwartz, M. (Ed.). Encyclopaedia of Coastal Science, pp. 192-193. ISBN 1-4020-1903-3.

Beets, D.J. & A.J.F. van der Spek, 2000. The Holocene evolution of the barrier and the back-barrier basins of Belgium and the Netherlands as a function of late Weichselian morphology, relative sea-level rise and sediment supply. Geologie en Mijnbouw / Netherlands Journal of Geosciences 79(1): 3-16.

Berghahn, R., 1987. The Wadden Sea as a nursery for fish and crustacean species. In: Proceedings of the 5th International Wadden Sea Symposium, Sep. 29th-Oct. 3rd 1986. Ed. by S. Tougaard& S. Asbirk. The National Forest and Nature Agency and the Museum of Fisheries and Shipping, Esbjerg, 69–85.

BirdLife International, 2004. Birds in Europe: population estimates, trends en conservation status. BirdLife International, Cambridge.

Blew, J. & P. Südbeck (Eds.), 2005. Migratory Waterbirds in the Wadden Sea 1980-2000. Wadden Sea Ecosystem No. 20. Common Wadden Sea Secretariat, Trilateral Monitoring and Assessment Group, Joint Monitoring Group of Migratory Birds in the Wadden Sea, Wilhelmshaven, Germany.

Cadée, G. C. & Hegeman, J., 1974a. Primary production of phytoplankton in the Dutch Wadden Sea. Neth. J. Sea Res. 8, 240-259.

Cadée, G. C. & Hegeman, J., 1974b. Primary production of the benthic microflora living on tidal flats in the Dutch Wadden Sea. Neth. J. Sea Res. 8, 260-291.

Camphuysen, K. & G. Peet, 2006. Whales and Dolphins of the North Sea. ‘s-Graveland, Fontaine Uitgevers bv. 159 p.

Cleveringa, J. & A. Oost, 1999. The fractal geometry of tidal-channel systems in the Dutch Wadden Sea. Geologie en Mijnbouw 78: 21-30. DOI 10.1023/A:1003779015372.

Dankers, N., K.S. Dijkema, J.A. van Franeker, M. Leopold, C.J. Smit & W.J. Wolff, 1993. Hst. 2: Inleiding voor de regio's van de maritieme invloedsfeer; Hst. 3: Afgesloten zeearmen; Hst. 4: Getijdegebied; Hst. 5: Noordzee. In: Leerdam, A. van, M.J. Wassen & N.Dankers. Onderzoek nagenoeg-natuurlijke referentie-ecosystemen. Interfacultaire

Vakgroep Milieukunde, RU Utrecht / DLO-Instituut voor Bos- en Natuuronderzoek, Utrecht; 12-13; 14-18; 19-29; 30-36.

Dankers, N., A. Meijboom, J.S.M. Cremer, E.M. Dijkman, Y. Hermes, & L. te Marvelde, 2003. Historische ontwikkeling van droogvallende mosselbanken in de Nederlandse Waddenzee. EVA-II-Alterra raport 876, 114 pp.

Dankers, N., A. Meijboom, M. de Jong, E. Dijkman, J. Cremer & S. van der Sluis 2004. Het ontstaan en verdwijnen van droogvallende mosselbanken in de Nederlandse Waddenzee. Alterra Rapport 921, 114 pp.

Dijkema K.S. & W.J. Wolff, 1983. Flora and vegetation of the Wadden Sea Islands and coastal areas. Report 9 of Wadden Sea Working Group. 413 pp. In: Wolff, W.J., 1983. Ecology of the Wadden Sea. Balkema Rotterdam (3 volumes).

Dijkema, K.S., W.G. Beeftink, J.P. Doody, J.M. Gehu, B. Heydemann & S. Rivas Martinez, 1984. Salt Marshes in Europe. Council of Europe, Nature and Environment: Series 30, Strasbourg. 178 pp.

Essink, K., C. Dettmann, H. Farke, K. Laursen, G. Lüerszen, H. Marencic & W. Wiersinga, (Eds), 2004. Wadden Sea Quality Status Report 2004. Wadden Sea Ecosystem No. 19 Trilateral Monitoring and Assessment Group, Common Wadden Sea Secretariat, Wilhelmshaven, Germany p. 211-218.

Hagemeijer, E.J.M., Smit C.J. (Eds.), de Boer, P., van Dijk, A.J., Ravenscroft, N., van Roomen, M.W.J. & Wright, M. 2004. Wader- and waterfowl count on the Banc d'Arguin, Mauritania, January-February 2000. WIWO report 81, Beek-Ubbergen, 146 p.

Halley, J.M., S. Hartley, A.S. Kallimanis, W.E. Kunin, J.J. Lennon and S.P. Sgardelis. Uses and abuses of fractal methodology in ecology. Ecology Letters 7: 254-271.

Hovenkamp, F. & H.W. van der Veer, 1993. De visfauna van de Nederlandse estuaria: Een vergelijkend onderzoek. Den Burg, NIOZ: 121 p.

Kam, J. van, B. Ens, T. Piersma & L. Zwarts, 1999. Ecologische atlas van de Nederlandse wadvogels. Haarlem, Schuyt, 368p. ISBN 906097509X.

Koffijberg, K., L. Dijksen, B. Hälterlein, K. Laursen, P. Potel & P. Südbeck, 2006. Breeding Birds in the Wadden Sea in 2001 - Results of the total survey in 2001 and trends in numbers between 1991-2001. Wadden Sea Ecosystem No. 22. Common Wadden Sea Secretariat, Trilateral Monitoring and Assessment Group, Joint Monitoring Group of Breeding Birds in the Wadden Sea, Wilhelmshaven, Germany.

Koppel, J. van der, M. Rietkerk, N. Dankers & P.M.J. Herman, 2005. Scale-Dependent Feedback and Regular Spatial Patterns in Young Mussel Beds. The American Naturalist 165(3): E66-E77.

Kromkamp, J.C., J.F.C. de Brouwer, G.F. Blanchard, R.M. Forster & V. Créach (Eds.), 2006. Functioning of microphytobenthos in estuaries. Amsterdam, Royal Netherlands Academy of Arts and Sciences. ISBN 90-6984-453-2.

Levin, S.A. The Problem of Pattern and Scale in Ecology: The Robert H. MacArthur Award Lecture. Ecology 73(6): 1943-1967.

MacIntyre, H., R.J. Geider & D.C. Miller, 1996. Microphytobenthos: The Ecological Role of the “Secret Garden” of Unvegetated, Shallow-Water Marine Habitats. I. Distribution, Abundance and Primary Production. Estuaries 19, No. 2A, 186-201.

Möbius, K., 1877. Die Auster und die Austernwirthschaft. Wiegund, Hempel and Parey. Berlin, 1-126.

Meltofte, H., J. Blew, J. Frikke, H-U Rösner & C.J. Smit, 1994. Numbers and distribution of waterbirds in the Wadden Sea; Results and evaluation of 36 simultaneous counts in the Dutch-German-Danish Wadden Sea 1980-1991. IWRB Publication 34 / Wader Study Group Bulletin 74, Special Issue.

Nordheim, E von, O. Norden Andersen, J. Thissen & T. Merck, 1996. General Introduction to the Lists of Threatened Biotopes, Flora and Fauna of the Trilateral Wadden Sea Area. Helgoländer Meeresunters. 50, Suppl, 1-8.

Rasmussen, L.M., O.G. Norden Andersen, J. Frikke, K. Laursen, J. Salvig, D.M. Fleet, B. Hälterlein, H. Heckenroth, T. Merck, H-U. Rösner, P. Südbeck, W.J. Wolff & J.B.M. Thissen, 1996. Red List of Birds of the Wadden Sea. Helgoländer Meeresunters. 50, Suppl, 113-128.

Reise, K., 2002. Sediment mediated species interactions in coastal waters. Journal of Sea Research 48: 127-141.

Reneerkens, J., T. Piersma & B. Spaans. De Waddenzee als kruispunt van vogeltrekwegen; Literatuurstudie naar de kansen en bedreigingen van wadvogels in internationaal perspectief. NIOZ-rapport 2005-4. ISNN 0923-3210.

Smit, C.J. & W.J. Wolff. 1980. Birds of the Wadden Sea; Final report of the section Birds of the Wadden Sea Working Group. Report 6 of the Wadden Sea Working Group, Stichting Veth tot Steun aan Waddenonderzoek, Leiden. ISBN 90 6191 056 0.

Smit, C.J. & T. Piersma, 1989. Numbers, midwinter distribution, and migration of wader populations using the East Atlantic flyway. In: H. Boyd & J.-Y. Pirot (eds.), Flyways and reserve networks for water birds. IWRB Special Publ. 9, Slimbridge, 24-63.

Ssymank, A. & N. Dankers 1996. Red List of Biotopes and Biotope Complexes of the Wadden Sea Area. Helgoländer Meeresunters. 50, 9-37.

Stallins, J.A., 2006. Geomorphology and ecology: Unifying themes for complex systems in biogeomorphology. Geomorphology 77: 207-216.

Thorup, O. (Ed.), 2006. Breeding waders in Europe: a year 2000 assessment. International Wader Studies 14, 3-131.

Turner, M.G., 1989. Landscape ecology: The Effect of Pattern of Process. Annu. Rev. Ecol. Syst. 20:171-197.

Vlas, J. de, B. Brinkman, C. Buschbaum, N. Dankers, M. Herlyn, P. Sand Kristensen, G. Millat, G. Nehls, M. Ruth, J. Steenbergen, A. Wehrman, 2005. Intertidal Blue Mussel beds. In: Essink, K., Dettmann, C., Farke, H., Laursen, K., Lüerszen, G., Marencic, H. & Wiersinga, W. (Eds). Wadden Sea Quality Status Report 2004. Wadden Sea Ecosystem No. 19 Trilateral Monitoring. and Assessment Group, Common Wadden Sea Secretariat, Wilhelmshaven, Germany. p. 190-200.

Wetlands International, 2002. Waterbird Population Estimates - Third Edition. Wetlands International Global Series No. 12, Wageningen, The Netherlands. 182 p.

Wolff, W.J. 1983. Ecology of the Wadden Sea. Balkema Rotterdam (3 volumes)

Zwarts, L. 1988. Numbers and distribution of coastal waders in Guinea-Bissau. *Ardea*, **76,** 42-55.

Justification

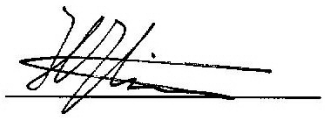
This report,

commissioned by: Ministry of Agriculture, Nature and Food Quality
Direction Regional Affairs, location North
P.O. Box
9700 RM Groningen

project number: 439.62105.01

has been produced with great care. The scientific quality has been peer-reviewed by Prof. Dr. Karsten Reise, Alfred Wegener Institute, Germany and assessed by or on behalf of the Scientific Board of Wageningen IMARES.

Dr. H.J. Lindeboom

Signature: 

Date: 27 March 2007

Annex 03

A Comparative Analysis of the Wadden Sea for the Nomination on the World Heritage list
Baptist, M.J., Dankers, N. and Smit, C. 2007.

A comparative analysis of the Wadden Sea for the nomination on the World Heritage list

M.J. Baptist, N. Dankers & C. Smit

Report C139/07

Institute for Marine Resources and Ecosystem Studies

Wageningen IMARES

Location Texel

Client: LNV DRZ-noord
Postbus 30032
9700 RM Groningen

Publication Date: January 2008

- Wageningen ***IMARES*** conducts research providing knowledge necessary for the protection, harvest and usage of marine and costal areas.
- Wageningen ***IMARES*** is a knowledge and research partner for governmental authorities, private industry and social organisations for which marine habitat and resources are of interest.
- Wageningen ***IMARES*** provides strategic and applied ecological investigation related to ecological and economic developments.

Photo cover by M.J. Baptist

Wageningen IMARES is a co-operative research organisation formed by Wageningen UR en TNO. We are registered in the Dutch trade record Amsterdam nr. 34135929, BTW nr. NL 811383696B04.

A_4_3_2-V4

Contents

Quality Assurance

IMARES utilises an ISO 9001:2000 certified quality management system (certificate number: 08602-2004-AQ-ROT-RvA). This certificate is valid until 15 December 2009. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V. The last certification inspection was held the 16-22 of May 2007. Furthermore, the chemical laboratory of the Environmental Division has NEN-AND-ISO/IEC 17025:2000 accreditation for test laboratories with number L097. This accreditation is valid until 27 March 2009 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation, with the last inspection being held on the 12th of June 2007.

1. Introduction

The format for the nomination of properties for inscription in the World Heritage List requires a comparative analysis (including state of conservation of similar properties) of the similar sites, whether on the World Heritage List or not. The comparison should outline the similarities the nominated property has with other properties and the reasons that make the nominated property stand out. The comparative analysis should aim to explain the importance of the nominated property both in its national and international context.

The objective is: a comparative table in which the Wadden Sea area to be nominated for inscription on the World Heritage List is compared with similar areas in the world, listed and non-listed.

2. Approach

2.1. Listed sites

As a first step in the comparison analysis, the currently 31 listed World Heritage sites with significant marine components and the 24 World Heritage coastal island sites with no (or insignificant) marine areas have been selected for further analysis. As a second step, sites have been selected that that host a high biodiversity and/or waterfowl and migratory birds. This results in 9 World Heritage sites, namely Galapagos National Park and Marine Reserve, Everglades National Park, Great Barrier Reef, Doñana National Park, The Sundarbans, Banc d´Arguin National Park, Fraser Island, Whale Sanctuary of El Vizcaíno and Greater St. Lucia Wetland Park.

Table 1: Preselected World Heritage sites, sizes and major biophysical setting.

World Heritage Site	Size (km^2)	Biophysical setting
Galapagos National Park and Marine Reserve	7,665	Volcanic archipelago and ocean
Everglades National Park	5,929	Freshwater and coastal marshes, mangrove swamps
Great Barrier Reef	348,700	Coral reef system and ocean
Doñana National Park	507	Coastal marshlands and dunes
Sundarbans (Bangladesh & India)	7,280	Deltaic islands, waterways, intertidal area with extensive mangrove cover
Banc d´Arguin National Park	12,000	Mudflats, dunes, islands
Fraser Island	1,663	Sand island
Whale Sanctuary of El Vizcaíno	3,710	Lagoons with some mangrove and seagrass
Greater St. Lucia Wetland Park	2,396	Coastal lakes, dunes and continental shelf

Firstly, it must be noted that all nine properties are located in a different biogeographical region than the Wadden Sea. The only European property is Doñana. The Doñana is located along the borders of the North-east Atlantic Ocean Region, whereas the Wadden Sea is located in the North Sea Region (EEA, 2002).

Secondly, many of the listed properties contain islands. The Galapagos are volcanic islands in an ocean surrounding, the Great Barrier reef has many coral islands, Fraser Island is an enormous sandy island, the Sundarbans consist of deltaic islands, Banc d'Arguin contains (partly rocky) islands and Florida Bay, which covers about 1800 km^2 of the Everglades National Park, contains hundreds of mangrove covered islands. However, the characteristics of these islands differ markedly from that of the Wadden islands.

Thirdly, and more important for the comparison with the Wadden Sea, the properties Sundarbans, Everglades (i.e., Florida Bay), Doñana and Banc d'Arguin contain intertidal flats within the property. The Wadden Sea is characterised by **extensive contiguous sand flats and mud flats.** The Sundarbans contain plots of mudflats mainly in the lee side of dunes, Florida Bay is a shallow lagoon

with mudflats fringing the mangrove covered islands, Doñana has a relatively small proportion of mudflats on the inner side along the banks of the Guadalquivir River, Greater St. Lucia has hardly any intertidal area and El Vizcaíno has some intertidal area covered with mangrove and seagrass.

The only World Heritage property that has extensive mudflats and with which the Wadden Sea can be compared, is the **Banc d´Arguin National Park** in Mauritania. Approximately 630 km^2 consists of intertidal mudflats (Hughes & Hughes, 1992). This is considerably smaller than the Wadden Sea, which has 4,534 km^2 of bare intertidal areas (Meltofte *et al*., 2004). Moreover, the Banc d'Arguin is of great importance for Palearctic migrating birds, as is the Wadden Sea. However, the Banc d'Arguin is located in a different biogeographical region and does not have barrier islands. In fact, the comparative analysis in the nomination dossier of the Parc national du Banc d'Arguin does not even consider the Wadden Sea as a comparable site. In their dossier a comparison is made with other areas with a combination of hot desert and coastal features.

2.2. Non-listed sites

The non-listed sites have been selected from various sources, in particular the overview by Deppe (2000). This overview is based on a broad number of sources (e.g. Ramsar Wetlands of International Importance, National Parks, Special Protected Areas, Wildlife Rerves).
Deppe (2000) described and compared 350 intertidal mudflat sites worldwide. Intertidal mudflat coasts may result from various geological and present day processes. At low tidal ranges lagoon-type mudflats may develop, at macrotidal ranges intertidal areas attached to the coast may develop, and many estuaries, bays and deltas contain mudflats.

Selection criteria
To be comparable to the Wadden Sea, which has over 4500 km^2 of intertidal mudflats, **a size criterion** of a minimum of 300 km^2 is applied to the long-list of 350 mudflat sites. This results in a total of 44 sites that qualify, Table 2.

Table 2: Mudflat sites in the world larger than 300 km^2 (in many cases the total size of the site is given, this is usually larger than the size of the intertidal flats).

Site	Size (km^2)	Coordinates	Type
Aqajarua-Sllorsuaq (Greenland)	300	69°40'N 52°00'W	Estuary
Qinnquata Marra-Kuussuaq (Greenland)	6000	69°56'N 54°17'W	Estuary
Baie du Mont Saint-Michel (France)	6200	48°40'N 01°40'W	Bay & estuary
Oosterschelde (Netherlands)	3800	51°30'N 04°10'E	Estuary
Kandalaksja Bay (Russia)	20800	65°N 35°E	Bays & estuaries
Karaginsky Island (Russia)	1936	58°45'N 163°42'E	Estuaries & open flats
Morecambe Bay (UK)	359	54°07'N 02°57'W	Bay & deltaic barrier
The Wash (UK)	622	52°56N 00°17'E	Bay & estuary
Upper Solway Flats & Marshes (UK)	307	54°54'N 03°25'W	Estuary
Archipelago dos Bijagos (Guinea-Bissau)	15700	12°20'N 16°00'W	Island coast & estuaries
St. Lucia (South-Africa)	1555	28°00'S 32°28'E	Estuary
Bahia Blanca (Argentine)	3000	38°50'S 62°00'W	Bay & estuary
Bahia de Samborombon (Argentine)	2440	35°47'S 57°50'W	Estuary
San Antonio Oeste Rio Negro (Argentine)	350	64°55'S 40°45'W	Bay
Dewey Soper (Canada)	8159	66°10'N 74°00'W	Open flats
Hudson Bay (Canada)	24087	52°30'N 84°30'W	Bay, estuaries & open flats
Queen Maud Gulf (Canada)	62782	67°00'N 102°00'W	Bay, estuaries & open flats
Bay of Fundy (Canada)	620	45°30'N 64°20'W	Bay & estuaries
Bigi Pan (Suriname)	683	05°55'N 56°45'W	Estuary & open flats
Wia Wia (Suriname)	900	05°56'N 54°55'W	Estuary & open flats
Chesapeake Bay (USA)	450	38°00'N 76°20'W	Bay & estuaries
Delaware Bay (USA)	512	39°11'N 75°14'W	Bay & estuaries
Georgia Bight (USA)	8000	32°17'N 80°35'W	Barrier islands & estuaries
Copper River Delta (USA)	1513	60°30'N 145°00'W	Deltaic barrier & estuaries
Delta del Rio Colorado (Mexico)	2500	31°50'N 114°59'W	Estuary
Khuran Straits (Iran)	1000	26°45'N 55°40'E	Estuary & deltaic barrier
Khor-al Amaya & Khor Musa (Iran)	4000	30°30'N 48°45'E	Estuaries & deltaic barriers
Kuwait Bay (Kuwait)	2000	29°20'N 48°00'E	Bay
Ras Al Khaymas (UAE)	3000	24°50'N 53°00'E	Barrier beach ridges
Gulf of Khambhat (India)	2500	21°50'N 72°23'E	Estuary
Korea Bay (China)	757	39°50'N 124°00'E	Estuary & bay
Liaodong Wan (China)	1247	40°00'N 121°50'E	Bay
Yellow river delta (China)	3712	37°50'N 118°50'E	Estuary
Korea Bay (North Korea)	1340	39°00'N 125°00'E	Estuary & bay
Yellow Sea coast (North Korea)	932	37°50'N 126°00'E	Estuaries & deltaic barriers
Yellow Sea coast (South Korea)	2900	36°00'N 127°00'E	Estuaries & deltaic barriers
Gulf of Thailand (Thailand)	400	13°20'N 100°25'E	Estuary & bay
Bowling Green Bay (Australia)	355	19°27'S 147°15'E	Estuary & bay
Corner Inlet (Australia)	672	38°45'S 146°32'E	Estuary & deltaic barriers
Eighty-mile Beach (Australia)	1250	19°29'S 120°35'E	Estuary & bays
Moreton Bay (Australia)	1133	27°20'S 153°10'E	Estuary & deltaic barriers
Roebuck Bay (Australia)	550	18°07'S 122°16'E	Bay
Shoalwater & Corio Bays (Australia)	2391	22°40'S 150°17'E	Estuaries & bay
Western Port (Australia)	593	38°22'S 145°17'E	Estuaries & deltaic barriers

The Wadden Sea mudflats are characterised by their location in tidal inlets of barrier islands. They contain a sequence of large and small ebb and flood gullies and their energy gradients follow from the morphology. The Wadden Sea (geological name: German Bight) is a mesotidal barrier island system that only has minor river influences fringing the flat and low-lying coastal plain. Most of the mudflat systems in the world are connected to estuaries and bays. Some are connected with barrier islands that are closely related to rivers and their deltas, such as the Mississippi delta. Only 5% of these deltaic barrier islands are found in North America and Europe, due to differing sea level rise history (Stutz & Pilkey, 2002). In North America and Europe, therefore, the barrier islands have a different geological origin. A second criterion, therefore, is the **presence of barrier islands that do not have a river delta origin**.

Of all sites larger than 300 km^2 this results in one comparable area: The **Georgia Bight**. The Georgia Bight (also named South Atlantic Bight) extends for a distance of 1200 km between Cape Hatteras in North Carolina to Cape Canaveral in Florida. Both the German Bight and the Georgia Bight are mesotidal barrier coasts that fall within the mixed energy / tide-dominated classification and both have a coastal development affected by Holocene sea level rise.

Comparing to non-listed areas, in the European context the Wadden Sea is unique in every respect in the European context. The Ria Formosa is a barrier island system and lagoon, but is a lot smaller (160 km^2) and does not contain the complex system of habitats and biotopes as the Wadden Sea. Morecambe Bay and The Wash have large mudflat areas, but are coastal bays, not barrier island coasts and they lack the specific morphological setting.

Other intertidal areas world-wide in the temperate region do not compare to the Wadden Sea. The Yellow Sea coast of China and Korea has a comparable mudflat size. However, there are no barrier islands like the Wadden Sea, the biophysical and biological features are different and the area is located on a different flyway. The Bay of Fundy and Delaware Bay and Chesapeake Bay for instance, have large mudflat areas, but have a very different morphological setting. Other areas are often located in different climate zones, but more important, do not have the non-deltaic barrier coast.

3. Comparison

Table 3 presents the comparison of the Wadden Sea with the two most similar areas. The Banc d'Arguin is comparable to the Wadden Sea for its function in the East Atlantic Flyway. Moreover, both areas are indispensable for the survival of millions of migrating birds and are thus linked over a distance of more than 4000 km. Apart from this, the Banc d'Arguin is situated in a different climate, has a very different morphological genesis and morphology and has a significantly smaller mudflat area, which is for the majority covered by seagrass.

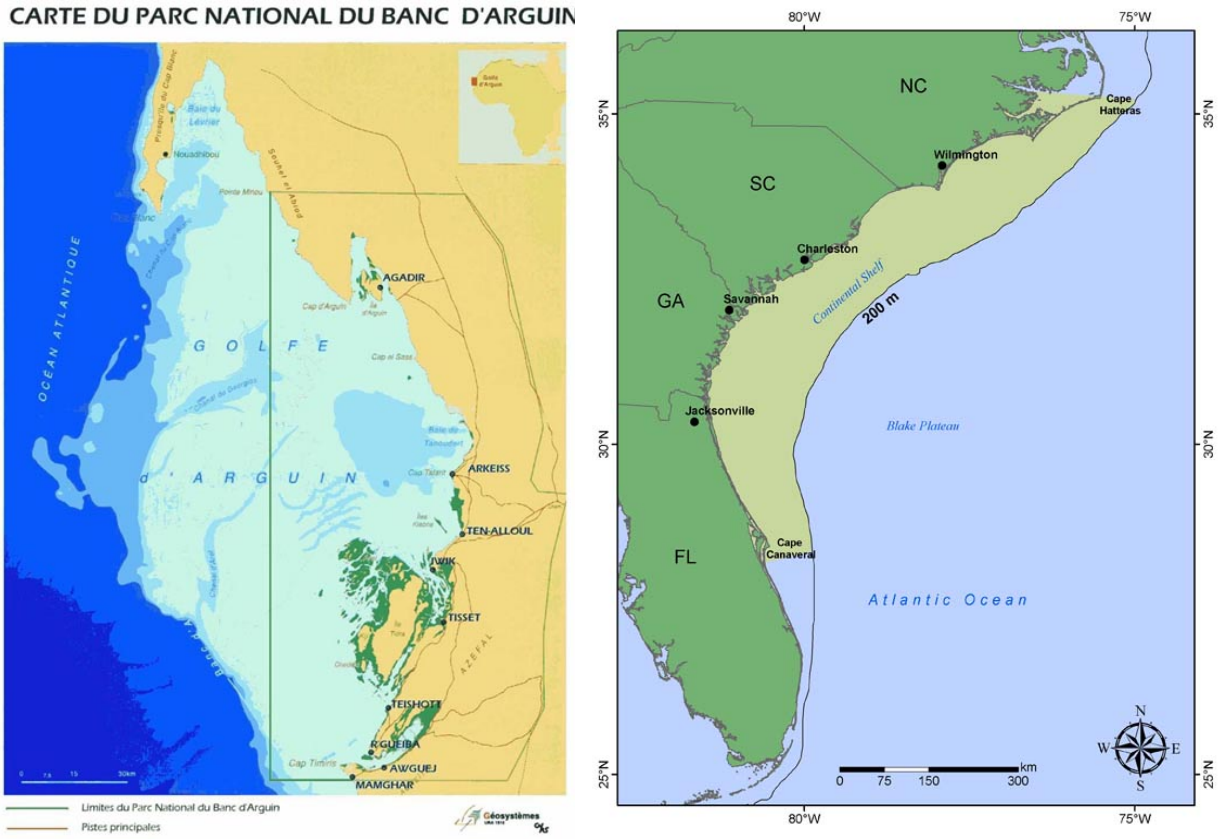
The most important (and major) difference between the Georgia Bight system and the Wadden Sea is that the Wadden Sea has open intertidal flats fringed by salt marshes, whereas the tidal basins along the Georgia Bight comprise tidal channels, narrow intertidal flats fringing the channels, and huge expanses of *Spartina* marsh which occupy what would otherwise have been open intertidal flats. The reason why *Spartina* has managed to encroach upon the former tidal flats is the large supply of mud (grain sizes <0.063 mm) to the coast by the local rivers. As a consequence, vertical accretion along the fringes of the marsh was so rapid that *Spartina* was able to occupy almost the entire intertidal area. The Georgia Bight tidal system thus looks very different from the Wadden Sea and also differs substantially in its ecology. A major difference to the Wadden Sea with a dominance of bare mudflats is a prevalence of the saltmarsh habitat while mudflats are marginal. At first glance, both systems are quite similar in their primary production. It should be noted, however, that the Wadden Sea is located between 52^o 53' N – 54^o 53' N, whereas the Georgia Bight is located between 28^o 28' N - 35^o 13' N, and receives considerably more light.

4. Conclusion

The Wadden Sea is to be regarded as of outstanding and unique universal value compared to similar areas world-wide.

Table 3: Comparison of Wadden Sea with Banc d'Arguin and Georgia Bight.

FEATURES	**Wadden Sea (maps in nomination dossier)**	**Banc d'Arguin (map below)**	**Georgia Bight (map below)**
designation WH	to be nominated	1989	not WH
country	Germany / Netherlands	Mauritania	USA
climate zone	temperate	continental, arid sub-tropics, dry	temperate
description setting	mixed energy to tide-dominated mesotidal barrier coast (not deltaic)	back barrier islands and open mud flats, relic of former deltas	mixed energy to tide-dominated mesotidal barrier coast (not deltaic)
total area	10,000 km^2	12,000 km^2 (50% marine)	~8,000 km^2
mudflat area	4,500 km^2	630 km^2	~300 km^2
tidal differences / range	1.5 – 3.5 m	2.1 m	0.8 – 2.5 m
mean wave height / range	1.0 – 2.0 m	1.4 m	0.6 – 1.0 m
contiguous character	large and contiguous area of intertidal habitats	contiguous between Cap Timiris and Pointe Minou, isolated section at Cap Blanc	not a contiguous intertidal system
habitats, biotopes	complex mosaic of bare intertidal flats fringed by saltmarshes, tidal channels, seagrass meadows, mussel beds	sand dunes, coastal swamps, small islands, intertidal areas with 80% seagrass cover	tidal channels with narrow band of bare intertidal flat. Intertidal almost completely covered by *Spartina* and *Juncus* saltmarshes
salt marshes km^2	310 km^2	591 km^2	4,237 km^2
mangroves km^2	none	31 km^2 mangrove *Avicennia africana*	some mangrove *Avicennia germinans*
major estuaries	5 estuaries	0 estuaries	13 estuaries
migrating birds	6,1 million present at the same time; on average 10 to 12 million each year; East Atlantic Flyway	2,1 million over-wintering birds (106 species) East Atlantic Flyway	Important stop-over for millions of migrating birds West Atlantic Flyway
productivity	Primary production (gC/m^2/**y**): phytoplankton 100-200 microphytes 150 seagrass 500 macrophytes 500-1000	Primary production (gC/m^2/**d**): phytoplankton 2.1-8.9	Primary production (gC/m^2/**y**): phytoplankton 200-400 microphytes 60 seagrass 150-700 macrophytes 800-2000
State of conservation	RAMSAR site, PSSA by the IMO, MAB by UNESCO, EU Natura 2000, EU WFD, contracting party of African-Eurasian Waterbird Agreement (AEWA)	RAMSAR site, National Park, has Fondation Internationale du Banc d'Arguin (FIBA) as management authority, **not** contracting party of AEWA	Not contiguously protected. Two Western Hemisphere Shorebird Reserves, Carolinian-South Atlantic MAB, **no** RAMSAR sites, **no** PSSA.



Overview maps of National Park **Banc d'Arguin** (source: http://effectivempa.noaa.gov/images/maps/bancdarguin_map_lg.jpg) and **Georgia Bight** (source: www.dnr.sc.gov/marine/sertc/index.html)

References

African-Eurasian Waterbird Agreement, http://www.unep-aewa.org/.

Alexander, C. & M. Robinson, 2004. Semi-annotated bibliography of barrier island studies Applicable to Georgia Back-Barrier Islands. Report from the Georgia Coastal Zone Management Program.

Anthony, E.J. & J.D. Orford, 2002. Between Wave- and Tide-Dominated Coasts: the Middle Ground Revisited. Journal of Coastal Research SI36, 8-15.

Berghuis, E.M., G.C.A. Duineveld & J. Hegeman, 1993. Primary production and distribution of phytopigments in the water column and sediments on the upwelling shelf off the Mauritanian coast (Northwest Africa). Hydrobiologia 258 : 81-93.

Dame, M. Alber, D. Allen, M. Mallin, C. Montague, A. Lewitus, A. Chalmers, R. Gardner, C. Gilman, B. Kjerfve, J. Pinckney & N. Smith, 2000. Estuaries of the South Atlantic Coast of North America: Their Geographical Signatures. Estuaries 23(6): 793-819.

Deppe, F, 2000. Intertidal Mudflats Worldwide. Wilhelmshaven, Common Wadden Sea Secretariat (CWSS), 100 p.

Duineveld, G.C.A., P.A.W.J. de Wilde, E.M. Berghuis & A. Kok, 1993. The benthic infauna and benthic respiration off the Banc d'Arguin (Mauritania, Northwest Africa). Hydrobiologia 258 : 107-117.

Engle, V.D. & J.K. Summers, 1999. Latitudinal gradients in benthic community composition in Western Atlantic estuaries. Journal of Biogeography 26: 1007-1023.

EEA, 2002. European Environment Agency Biogeographical Regions and Seas: http://reports.eea.europa.eu/report_2002_0524_154909/en.

Fondation Internationale du Banc d'Arguin (FIBA), http://www.fibarguin.org/.

Jager, Z., 1993. The distribution and abundance of young fish in the Banc d'Arguin, Mauritania. Hydrobiologia 258 : 185-196.

Hagemeijer, E.J.M., Smit C.J. (Eds.), de Boer, P., van Dijk, A.J., Ravenscroft, N., van Roomen, M.W.J. & Wright, M., 2004. Wader- and waterfowl count on the Banc d'Arguin, Mauritania, January-February 2000. WIWO report 81, Beek-Ubbergen, 146 p.

Hughes R. & S. Hughes, 1992. Directory of African Wetlands. IUCN, Switzerland /UNEP, Nairobi / WCMC, Cambridge, UK.

Man and the Biosphere Program, http://www.unesco.org/mab/.

Meltofte, H., J. Blew, J. Frikke, H-U Rösner & C.J. Smit, 1994. Numbers and distribution of waterbirds in the Wadden Sea; Results and evaluation of 36 simultaneous counts in the Dutch-German-Danish Wadden Sea 1980-1991. IWRB Publication 34 / Wader Study Group Bulletin 74, Special Issue.

Particularly Sensitive Sea Areas (PSSA), http://www.imo.org/.

Ramsar Convention on Wetlands, http://www.ramsar.org/.

Rousseau, S. & P. Forget, 2004. Ocean wave mapping from ERS SAR images in the presence of swell and wind waves. Scientia Marina 68(1): 1-5.

Searles, R.B., 1984. Seaweed biogeography of the mid-Atlantic coast of the United States. Helgoländer Meeresuntersuchüngen 38: 259-271.

Stallins, J.A., 2000. Barrier Island Morphology and Dune Vegetation Pattern and Process in the Georgia Bight. Georgia, University of Georgia, PhD-thesis, 217 p.

Stutz, M.L. & O.H. Pilkey, 2002. Global distribution and morphology of deltaic barrier island systems. Journal of Coastal Research SI 36: 694-707.

Thorsell, J., R. Ferster Levy & T. Sigaty, 1997. A global overview of wetland and marine protected areas on the World Heritage list. Gland, Switzerland, IUCN, 47 p.

UNESCO, 1989. IUCN Technical Evaluation Banc d'Arguin National Park. 17 p.

Vermaat, J.E., J.A.J. Beijer, R. Gijlstra, M.J.M. Hootsmans, C.J.M. Philippart, N.W. van der Brink and W. van Vierssen, 1993. Leaf dynamics and standing stocks of intertidal Zostera noltii Horneman and Cymodocea nodosa (Ucria) Ascherson on the Banc d'Arguin (Mauritania). Hydrobiologia 258**:** 59–72.

Watson, C., C. Hayes, J. McCauley, A. Milliken, 2004. The South Atlantic Migratory Bird Initiative – An Integrated Approach to Conservation of "All Birds Across All Habitats". USDA Forest Service Gen. Tech. Rep. PSW-GTR-191.

Western Hemisphere Shorebird Reserves network, http://www.whsrn.org/.

Wigh, R. A review of bird species on the South Atlantic Bight. Report on skidaway.net.

Wolff, W.J., J. van der Land, P.H. Nienhuis & P.A.W.J. de Wilde, 1993. The functioning of the ecosystem of the Banc d'Arguin, Mauritania : a review. Hydrobiologia 258 : 211-222

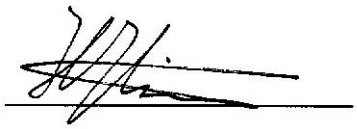
Referees and Authors

Report C139/07
Project Number: 439.62118.01

Baptist, M.J., 2007. A comparative analysis of the Wadden Sea for the nomination on the World Heritage list. Wageningen IMARES report C139/07, 12 pp.

This report has been professionally prepared by Wageningen IMARES. The scientific quality has been peer-reviewed by Jens Enemark of the International Wadden Sea Secretariat, Germany and assessed by or on behalf of the Scientific Board of Wageningen IMARES.

Approved: dr. H. Lindeboom
Scientific Director

Signature: 

Date: 7. January 2008

Number of copies:	15
Number of pages	12
Number of tables:	3
Number of graphs:	2
Number of appendix attachments:	0

Annex 04

List of Wadden Sea fish species

List of Wadden Sea fish species

compiled by Ralf Vorberg

Main tasks of the TMAP ad-hoc working group fish are the development of targets and assessment tools for trilateral Wadden Sea fish. A possible target could be "presence of a typical Wadden Sea fish fauna". As a provisional assessment tool a priority list of Wadden Sea fish species was defined, using data from the existing demersal and pelagic fish surveys. Another tool could be the definition of a range for species composition and/or species abundances. For this purposes a comprehensive compilation of fish species occurring in the Wadden Sea turned out to be useful.

Information derived from running monitoring programmes as the 30-year data sets of the demersal (young) fish survey, DFS and DYFS as listed in table, in the Netherlands and Germany and of the stow net fishery in Schleswig-Holstein, Lower Saxony and from the river Elbe. In addition species lists from the literature were used (Zijlstra et al., 1979; Fricke et al., 1994; Vorberg & Breckling, 1999).

The compilation of Wadden Sea fish species yielded a total of 149 proofs, of which 13 are freshwater species The total number of North Sea fish species at the moment is 189 (Fröse & Pauly 2007). what means that about 72% of all North Sea fish species (can) occur in the Wadden Sea. With regard to a trilateral monitoring and assessment program only one half of all species is of practical importance: 50 species (33,6%) are common, 25 species (16,8%) are fairly common. 74 species (49,7%) have to be regarded as rare or even extremely rare in the Wadden Sea.

Literature

FRICKE, R.; BERGHAHN, R.; RECHLIN, O.; NEUDECKER, T.; WINKLER, H.; BAST, H.-D. & HAHLBECK, E. (1994): Rote Liste und Artenverzeichnis der Rundmäuler und Fische (Cyclostomata Pisces) im Bereich der deutschen Nord- und Ostsee. IN: NOWAK, E.; BLAB, J. & BLESS, R.: Rote Liste der gefährdeten Wirbeltiere in Deutschland. - Kilda Vlg.: 157-176.

FROESE, R. and D. PAULY. Editors. 2007.FishBase. World Wide Web electronic publication. www.fishbase.org, version (02/2007).

VORBERG, R. & BRECKLING, P. (1999): Atlas der Fische im schleswig-holsteinischen Wattenmeer. Schriftenreihe des Nationalparks Schleswig-Holsteinisches Wattenmeer, Heft 10: 180 S.

WITTE, J.Y. & ZIJLSTRA, J.J. (1979): The species of fish occurring in the Wadden Sea. In. DANKERS, N.; WOLFF, W.J. & ZIJLSTRA, J.J.: Fishes and fisheries of the Wadden Sea. - A. A. Balkema, Rotterdam: 10-25.

No	Scientific name	English name	German name	Dutch name	DYFS	DFS	Witte & Zijlstra	Red List	occurrence (e)r: (extremely) rare fc: fairly common c: common
1	Abramis brama	Carp Bream	Brasse	Brasem	x				(e)r
2	Acipenser sturio	Sturgeon	Stör	Steur			x	x	(e)r
3	Agonus cataphractus	Hooknose	Steinpicker	Harnasmannetje	x	x	x	x	c
4	Alburnus alburnus	Bleak	Ukelei	Alver					(e)r
5	Alopias vulpinus	Thresher	Fuchshai	Voshaai			x		(e)r
6	Alosa alosa	Allis Shad	Maifisch	Elft		x	x	x	fc
7	Alosa fallax	Twaite Shad	Finte	Fint	x		x	x	c
8	Ammodytes marinus	Lesser Sandeel	Kleiner Sandaal	Noorse Zandspiering	x	x	x	x	c
9	Ammodytes tobianus	Small Sandeel	Tobiasfisch	Zandspiering				x	(e)r
10	Anarhichas denticulatus	Northern Wolffish	Blauer Seewolf	Zeewolf				x	(e)r
11	Anguilla anguilla	Eel	Aal	Aal	x	x	x	x	c
12	Aphia minuta	Transparent Goby	Glasgrundel	Glasgrondel		x	x	x	c
13	Argyrosomus regius	Meagre	Umberfisch	Ombervis				x	(e)r
14	Arnoglossus laterna	Scaldfish	Lammzunge	Schurftvis	x	x	x	x	c
15	Aspitrigla cuculus	Red Gurnard	Seekuckuck	Engelse Poon			x	x	(e)r
16	Aspius aspius	Asp	Rapfen						(e)r
17	Atherina presbyter	Sand-smelt	Ährenfisch	Koornaarvis	x	x	x	x	c
18	Atherina boyeri	Big-scale Sand Smelt	Kleiner Ährenfisch	Kleine Koornaarvis				x	(e)r
19	Barbus barbus	Barbel	Barbe	Barbeel					(e)r
20	Balistes carolinensis	Trigger-Fish	Grauer Drückerfisch	Trekkervis			x		(e)r
21	Belone belone	Garfish	Hornhecht	Geep	x	x	x	x	c
22	Blicca bjoerkna	White Bream	Güster	Kolblei	x				(e)r
23	Boops boops	Bogue	Gelbstrieme	Bokvis			x	x	(e)r
24	Brama brama	Ray's Bream	Brachsenmakrele	Braam			x	x	(e)r
25	Buglossidium luteum	Solenette	Zwergzunge	Dwergtong	x	x	x	x	c
26	Callionymus lyra	Dragonet	gestreifter Leierfisch	Pitvis	x	x	x	x	c
27	Callionymus maculatus	Spotted Dragonet	gefleckter Leierfisch	Rasterpitvis	x				(e)r
28	Callionymus reticulatus	Reticulated Dragonet	Ornament-Leierfisch	Gevlektepitvis	x		x		(e)r
29	Carassius carassius	Crucian Carp	Karausche	Kroeskarper					(e)r
30	Cetorhinus maximus	Basking Shark	Riesenhai	Reuzehaai			x		(e)r

31	Cheilopogon heterurus	Atlantic Flying-Fish	Fliegender Fisch					x	(e)r
32	Chelon labrosus	Thick-lipped Mullet	Dicklippige Meeräsche	Diklip Harder	x	x	x	x	c
33	Ciliata mustela	Five-bearded Rockling	Fünfbärtelige Seequappe	Vijfdradige Meun	x	x	x	x	c
34	Clupea harengus	Herring	Hering	Haring	x	x	x	x	c
35	Conger conger	Conger Eel	Meeraal	Zeepaling			x	x	(e)r
36	Coregonus oxyrinchus	Houting	Nordseeschnäpel	Houting			x	x	fc
37	Crystallogobius linearis	Crystal Goby	Kristallgrundel					x	(e)r
38	Ctenolabrus rupestris	Goldsinny	Klippenbarsch	Kliplipvis			x		(e)r
39	Cyclopterus lumpus	Lumpsucker	Seehase	Snotolf	x	x	x	x	c
40	Cynoglossus browni	Nigerian tonguesole	Hundszunge					x	(e)r
41	Cyprinus carpio	Carp	Karpfen	Karper					(e)r
42	Dasyatis pastinaca	Common Stingray	Stechrochen	Pijlstaartrog		x	x	x	fc
43	Dentex maroccanus	Morocco Dentex	Marokkanische Zahnbrasse					x	(e)r
44	Dicentrarchus labrax	Sea Bass	Wolfsbarsch	Zeebaars	x	x	x	x	c
45	Echiichthys vipera	Lesser Weever	Vipernqueise	Kleine Pieterman	x	x	x	x	fc
46	Enchelyopus cimbrius	Four-bearded Rockling	Vierbärtelige Seequappe	Vierdradige Meun		x	x	x	fc
47	Engraulis encrasicolus	Anchovy	Sardelle	Ansjovis	x	x	x	x	c
48	Entelurus aequoreus	Snake Pipefish	Große Schlangennadel	Adderzeenaald	x	x	x	x	c
49	Eutrigla gurnadus	Grey Gurnard	Grauer Knurrhahn	Grauwe Poon	x	x	x	x	c
50	Gadus morhua	Cod	Kabeljau	Kabeljauw	x	x	x	x	c
51	Gaidropsarus mediterranaeus	Shore Rockling	Mittelmeer-Seequappe						(e)r
52	Gaidropsarus vulgaris	Three-bearded Rockling	Dreibärtelige Seequappe	Driedradige Meun	x	x	x	x	fc
53	Galeorhinus galeus	Tope Shark	Hundshai	Ruwehaai			x	x	fc
54	Galeus melastomus	Blackmouth Catshark	Fleckhai	Hondshaai				x	(e)r
55	Gasterosteus aculeatus	Stickleback	Dreistacheliger Stichling	Driedoornige Stekelbaars	x	x	x	x	c
56	Glyptocephalus cynoglossus	Witch	Hundszunge	Witje	x			x	fc
57	Gobiusculus flavescens	Two-spotted Goby	Schnappgrundel					x	(e)r
58	Gymnocephalus cernuus	Ruffe	Kaulbarsch	Pos	x	x			fc
59	Hexanchus griseus	Bluntnose Sixgill Shark	Grauhai	Grauwe Haai				x	(e)r
60	Hippocampus hippocampus	Sea-Horse	Seepferdchen	Zeepaardje			x		(e)r

61	Hippoglossoides platessoides	American Plaice	Doggerscharbe	Lange Schar	x			x	fc
62	Hyperoplus immaculatus	Greater Sand-Eel	Ungefleckter Großer Sandaal					x	(e)r
63	Hyperoplus lanceolatus	Great Sandeel	Gefleckter Großer Sandaal	Smelt	x	x	x	x	c
64	Labrus bergylta	Balan Wrasse	Gefleckter Lippfisch	Gevlekte Lipvis			x		(e)r
65	Lamna nasus	Porbeagle	Heringshai	Neushaai			x		(e)r
66	Lampetra fluviatilis	River Lamprey	Flußneunauge	Rivierprik	x	x	x	x	c
67	Leucaspius delineatus	Sunbleak	Moderlieschen	Vetje					(e)r
68	Leuciscus idus	Ide	Orfe	Winde					(e)r
69	Limanda limanda	Dab	Kliesche	Schar	x	x	x	x	c
70	Liparis liparis	Sea Snail	Großer Scheibenbauch	Slakdolf	x	x	x	x	c
71	Liparis montagui	Montagu's Sea Snail	Kleiner Scheibenbauch	Montagu's Slakdolf	x			x	c
72	Lipophrys pholis	Shanny	Schan	Slijmvis			x	x	(e)r
73	Liza aurata	Golden Grey Mullet	Goldmeeräsche	Goudharder			x	x	(e)r
74	Liza ramada	Thin-lipped Grey Mullet	Dünnlippige Meeräsche	Dunlip Harder			x	x	(e)r
75	Lophius piscatorius	Angler	Seeteufel	Zeeduivel			x		(e)r
76	Maurolicus muelleri	Pearlsides	Lachshering	Lichtend Sprotje			x	x	fc
77	Melanogrammus aeglefinus	Haddock	Schellfisch	Schelvis			x	x	(e)r
78	Merlangius merlangus	Whiting	Wittling	Wijting	x	x	x	x	c
79	Merluccius merluccius	European Hake	Seehecht	Heek	x		x	x	fc
80	Micromesistius poutassou	Blue Whiting	Blauer Wittling	Blauwe Wijting			x	x	fc
81	Microstomus kitt	Lemon Sole	Limande, Rotzunge	Tongschar	x	x	x	x	c
82	Mola mola	Sunfish	Mondfisch	Maanvis			x	x	(e)r
83	Molva molva	Ling	Leng	Leng					(e)r
84	Mullus barbatus	Red Mullet	Rote Meerbarbe					x	(e)r
85	Mullus surmelutus	Surmullet	Streifenbarbe	Mul	x	x	x	x	c
86	Mustelus mustelus	Smooth Hound	Glatthai	Gladde Haai			x		(e)r
87	Myoxocephalus scorpius	Bull Rout	Seeskorpion	Zeedonderpad	x	x	x	x	c
88	Nerophis lumbriciformis	Worm Pipefish	Krummschnauzige Schlangennadel					x	(e)r
89	Onchorhynchus mykiss	Rainbow Trout	Regenbogenforelle	Regenboogforel					(e)r
90	Osmerus eperlanus	Smelt	Stint	Spiering	x	x	x	x	c
91	Pagellus acarne	Axillary Seabream	Achselfleckbrasse	Spaanse Zeebrasem				x	(e)r

92	Pagellus bogaraveo	Blackspotted Seabream	Graubarsch	Zeebrasem				x	(e)r
93	Pagellus erythrinus	Common Pandora	Rotbrasse	Zeebrasem				x	(e)r
94	Parablennius gattorugine	Tompot Blenny	Gestreifter Schleimfisch	Gehoornde Slijmvis			x	x	(e)r
95	Perca fluviatilis	European Perch	Flussbarsch	Baars		x			(e)r
96	Petromyzon marinus	Sea Lamprey	Meerneunauge	Zeeprik		x	x	x	c
97	Pholis gunellus	Butterfish	Butterfisch	Botervis	x	x	x	x	c
98	Phrynorhombus norvegicus	Norwegian topknot	Norwegischer Zwergbutt	Dwergtarbot				x	(e)r
99	Platichthys flesus	Flounder	Flunder	Bot	x	x	x	x	c
100	Pleuronectes platessa	Plaice	Scholle	Schol	x	x	x	x	c
101	Pollachius pollachius	Pollack	Pollack	Pollak		x	x	x	fc
102	Pollachius virens	Saithe	Seelachs	Koolvis	x	x	x	x	fc
103	Pomatoschistus lozanoi	Lozano's Goby	Lozanos Grundel	Lozanos Grondel		x	x	x	fc
104	Pomatoschistus microps	Common Goby	Strandgrundel	Brakwatergrondel	x		x	x	c
105	Pomatoschistus minutus	Sand Goby	Sandgrundel	Dikkopje	x		x	x	c
106	Pomatoschistus pictus	Painted Goby	Fleckengrundel	Kleurige Grondel			x		fc
107	Psetta maxima	Turbot	Steinbutt	Tarbot	x	x	x	x	c
108	Pterycombus brama	Atlantic Fanfish	Silberbrassen	Zilverbraam				x	(e)r
109	Pungitius pungitius	Ninespine Stickleback	Zwergstichling	Tiendoornige stekelbaars	x			x	fc
110	Raja clavata	Thornback	Nagelrochen	Stekelrog			x	x	(e)r
111	Raniceps raninus	Tadpole-Fish	Froschdorsch	Vorskwab			x		(e)r
112	Remora remora	Common Remora	Ansauger	Remora				x	(e)r
113	Rutilus rutilus	Roach	Rotauge	Blankvoorn		x			(e)r
114	Salmo salar	Salmon	Lachs	Zalm	x		x	x	c
115	Salmo trutta	Sea Trout	Meerforelle	Zeeforel	x		x	x	c
116	Sardina pilchardus	Sardine	Sardine	Sardien	x	x	x	x	c
117	Scomber japonicus	Chub Mackerel	Mittelmeermakrele	Spaanse Makreel				x	(e)r
118	Scomber scombrus	Mackerel	Atlantische Makrele	Makreel	x	x	x	x	c
119	Scomberesox saurus	Skipper	Makrelenhecht	Makreelgeep			x		(e)r
120	Scophthalmus rhombus	Brill	Glattbutt	Griet	x	x	x	x	c
121	Scyliorhinus caniculus	Lesser spotted Dogfish	Kleingefleckter Katzenhai	Hondshaai			x	x	(e)r
122	Scyliorhinus stellaris	Greater spotted Dogfish	Großgefleckter Katzenhai	Kathaai				x	(e)r
123	Sebastes marinus	Redfish	Rotbarsch	Noorse Schelvis			x		(e)r

124	Serranus cabrilla	Comber	Sägebarsch	Zaagbaars				x	(e)r
125	Solea solea	Sole	Seezunge	Tong	x	x	x	x	c
126	Spinachia spinachia	Sea Stickleback	Seestichling	Zeestekelbaars	x		x	x	fc
127	Spodyliosoma cantharus	Black Sea Bream	Streifenbrasse	Zeekarper			x		(e)r
128	Sprattus sprattus	Sprat	Sprotte	Sprot	x	x	x	x	c
129	Squalus acanthias	Spur-Dog	Dornhai	Doornhaai			x		(e)r
130	Squatina squatina	Monkfish	Meerengel	Zeeengel			x	x	(e)r
131	Stizostedion lucioperca	Pike Perch	Zander	Snoekbaars	x	x		x	fc
132	Symphodus melops	Corkwing	Goldmaid	Zwaartooglipvis			x		(e)r
133	Syngnathus acus	Great Pipefish	Große Seenadel	Grote Zeenaald		x	x	x	c
134	Syngnathus rostellatus	Nilsson's Pipefish	Kleine Seenadel	Kleine Zeenaald	x	x	x	x	c
135	Syngnathus typhle	Deep-snouted Pipefish	Grasnadel	Trompetterzeenaald			x	x	fc
136	Taractes asper	Rough pomfret	Kleine Brachsenmakrele					x	(e)r
137	Taractichthys longipinnis	Bigscale Pomfret	Langflossen-Brachsenmakrele					x	(e)r
138	Taurulus bubalis	Long-spined Sea Scorpion	Seebull	Groene Zeeonderpad			x	x	fc
139	Trachinotus ovatus	Derbio	Gabelmakrele	Gaffelmakreel				x	(e)r
140	Trachinus draco	Greater Weaver	Petermännchen	Grote Pieterman	x		x	x	fc
141	Trachurus trachurus	Horse Mackerel	Stöcker	Horsmakreel	x	x	x	x	c
142	Trigla lucerna	Tub Gurnard	Roter Knurrhahn	Rode Poon	x	x	x	x	c
143	Trisopterus esmarki	Norway Pout	Stintdorsch	Kever	x			x	fc
144	Trisopterus luscus	Bib	Franzosendorsch	Steenbolk	x	x	x	x	c
145	Trisopterus minutus	Poor Cod	Zwergdorsch	Dwergbolk	x	x	x	x	fc
146	Xiphias gladius	Sword-Fish	Schwertfisch	Zwaardvis			x		(e)r
147	Zeugopterus punctatus	Topknot	Haarbutt	Gevlekte Griet			x	x	(e)r
148	Zeus faber	Dory	Heringskönig	Zonnevis			x		(e)r
149	Zoarces viviparus	Eelpout	Aalmutter	Puitaal	x	x	x	x	c

Annex 05

List of Wadden Sea bird species

List of Wadden Sea bird species

The table below indicates the birds species monitored in the trilateral Joint Monitoring of Migratory/Breeding Birds program to the EU Birds Directive.

Bird species are listed
a) according EU Birds Directive Annex I/II in Special Protection Areas (SPA) of the Wadden Sea in DK, SH, HH, Nds, and NL and
b) in the trilateral "Joint Monitoring of Migratory Birds" (JMMB) and "Joint Monitoring of Breeding Birds" (JMBB) program

Remark:
B,M,BM - bird linked as "Breeding", "Migratory" or as "Breeding and Migratory" bird to SPA.

No	Species, scientific name	SH	HH	Nds	NL	DK	JMMB JMBB	German name	Dutch name	Order	Family
1	Red-Throated Diver (Gavia stellata)	M		M	M			Sterntaucher	Roodkeelduiker	Gaviiformes	Gaviidae
2	Black-Throated Diver (Gavia arctica)	M			M			Prachttaucher	Parelduiker	Gaviiformes	Gaviidae
3	Little Grebe (Tachybaptus ruficollis)				M			Zwergtaucher	Dodaars	Podicipediformes	Podicipedidae
4	Great Crested Grebe (Podiceps cristatus)				M			Haubentaucher	Fuut	Podicipediformes	Podicipedidae
5	Red-Necked Grebe (Podiceps grisegena)							Rothalstaucher	Roodhalsfuut	Podicipediformes	Podicipedidae
6	Black-Necked Grebe (Podiceps nigricollis)	M						Schwarzhalstaucher	Geoorde Fuut	Podicipediformes	Podicipedidae
7	Northern Fulmar (Fulmarus glacialis)							Eissturmvogel	Noordse Stormvogel	Procellariiformes	Procellariidae
8	Great Cormorant (Phalacrocorax carbo)	BM		BM	BM		BM	Kormoran	Aalscholver	Pelecaniformes	Phalacrocoracidae
9	Bittern (Botaurus stellaris)	B		B	B	B		Rohrdommel	Roerdomp	Ciconiiformes	Ardeidae
10	Little Egret (Egretta garzetta)				BM		B	Seidenreiher	Kleine Zilverreiger	Ciconiiformes	Ardeidae
11	Grey Heron (Ardea cinerea)	M						Graureiher	Blauwe Reiger	Ciconiiformes	Ardeidae
12	White Stork (Ciconia ciconia)	B		B		B		Weißstorch	Ooievaar	Ciconiiformes	Ciconiidae
13	Eurasian Spoonbill (Platalea leucorodia)	BM		BM	BM		BM	Löffler	Lepelaar	Ciconiiformes	Threskiornithidae
14	Mute Swan (Cygnus olor)			M				Höckerschwan	Knobbelzwaan	Anseriformes	Anatidae
15	Bewick's Swan (Cygnus columbianus bewickii)	M		M	M	M		Zwergschwan	Kleine Zwaan	Anseriformes	Anatidae
16	Whooper Swan (Cygnus cygnus)	M		M		M		Singschwan	Wilde Zwaan	Anseriformes	Anatidae
17	Bean Goose (Anser fabalis)				M			Saatgans	Toendrarietgans	Anseriformes	Anatidae
18	Pink-Footed Goose (Anser brachyrhynchus)					M		Kurzschanbelgans	Kleine Rietgans	Anseriformes	Anatidae
19	White-Fronted Goose (Anser albifrons)	M		M				Blaessgans	Kolgans	Anseriformes	Anatidae
20	Greylag Goose (Anser anser)	M		M	M	M	M	Graugans	Grauwe Gans	Anseriformes	Anatidae
21	Barnacle Goose (Branta leucopsis)	BM		M	M	M	BM	Nonnengans, Weißwangengans	Brandgans	Anseriformes	Anatidae
22	Brent Goose (Branta bernicla)	M	M	M	M		M	Ringelgans	Rotgans	Anseriformes	Anatidae
23	Shelduck (Tadorna tadorna)	BM		M	M	BM	BM	Brandgans	Bergeend	Anseriformes	Anatidae
24	Wigeon (Anas penelope)	M		M	M	BM	BM	Pfeifente	Smient	Anseriformes	Anatidae
25	Gadwall (Anas strepera)			B	M			Schnatterente	Krakeend	Anseriformes	Anatidae
26	Teal (Anas crecca)	M		BM	M		M	Krickente	Wintertaling	Anseriformes	Anatidae
27	Mallard (Anas platyrhynchos)	M		M	M		M	Stockente	Wilde Eend	Anseriformes	Anatidae
28	Pintail (Anas acuta)	M		M	M	BM	BM	Spießente	Pijlstaart	Anseriformes	Anatidae
29	Garganey (Anas querquedula)	M		B				Knäkente	Zomertaling	Anseriformes	Anatidae
30	Shoveler (Anas clypeata)	M		BM	M	M	M	Löffelente	Slobeend	Anseriformes	Anatidae
31	Scaup (Aythya marila)				M			Bergente	Toppereend	Anseriformes	Anatidae
32	Common Eider (Somateria mollissima)	BM		BM	BM	BM	BM	Eiderente	Eidereend	Anseriformes	Anatidae
33	Common Scoter (Melanitta nigra)	M		M	M			Trauerente	Zwarte Zeeeend	Anseriformes	Anatidae

34	Goldeneye (Bucephala clangula)				M			Schellente	Brilduiker	Anseriformes	Anatidae
35	Smew (Mergus albellus)	M						Zwergsäger	Nonnetje	Anseriformes	Anatidae
36	Red-breasted Merganser (Mergus serrator)	BM			M		B	Mittelsäger	Middelste Zaagbek	Anseriformes	Anatidae
37	Goosander (Mergus merganser)				M			Gänsesäger	Grote Zaagbek	Anseriformes	Anatidae
38	Red Kite (Milvus milvus)							Rotmilan	Rode Wouw	Falconiformes	Accipitridae
39	White-Tailed Eagle (Haliaeetus albicilla)	M			M		M	Seeadler	Zeearend	Falconiformes	Accipitridae
40	Marsh Harrier (Circus aeruginosus)	B		B	B	B		Rohrweihe	Bruine Kiekendief	Falconiformes	Accipitridae
41	Hen Harrier (Circus cyaneus)	B		B	B	BM	B	Kornweihe	Blauwe Kiekendief	Falconiformes	Accipitridae
42	Montagu's Harrier (Circus pygargus)	B		B		B		Wiesenweihe	Grauwe Kiekendief	Falconiformes	Accipitridae
43	Rough-Legged Buzzard (Buteo lagopus)						M	Rauhfußbussard	Ruigpootbuizerd	Falconiformes	Accipitridae
44	Merlin (Falco columbarius)						M	Merlin	Smelleken	Falconiformes	Falconidae
45	Peregrine Falcon (Falco peregrinus)	B	BM		M		M	Wanderfalke	Slechtvalk	Falconiformes	Falconidae
46	Water Rail (Rallus aquaticus)			B				Wasserralle	Waterral	Gruiformes	Rallidae
47	Spotted Crake (Porzana porzana)	B		B	B	B		Tüpfelsumpfhuhn	Porseleinhoen	Gruiformes	Rallidae
48	Corn Crake (Crex crex)	B		B		B		Wachtelkönig	Kwartelkoning	Gruiformes	Rallidae
49	Oystercatcher (Haematopus ostralegus)	BM	BM	M	M	BM	BM	Austernfischer	Scholekster	Charadriiformes	Haematopoditae
50	Black-Winged Stilt (Himantopus himantopus)							Stelzenläufer	Steltkluut	Charadriiformes	Recurvirostridae
51	Avocet (Recurvirostra avosetta)	BM	BM	BM	BM	BM	BM	Säbelschnäbler	Kluut	Charadriiformes	Recurvirostridae
52	Great Ringed Plover (Charadrius hiaticula)	BM	BM	M	BM		BM	Sandregenpfeifer	Bontbekplevier	Charadriiformes	Charadriidae
53	Kentish Plover (Charadrius alexandrinus)	BM		B	BM	BM	BM	Seeregenpfeifer	Strandplevier	Charadriiformes	Charadriidae
54	Golden Plover (Pluvialis apricaria)	M	M	M	M	M	M	Goldregenpfeifer	Goudplevier	Charadriiformes	Charadriidae
55	Grey Plover (Pluvialis squatarola)	M	M	M	M	M	M	Kiebitzregenpfeifer	Zilverplevier	Charadriiformes	Charadriidae
56	Northern Lapwing (Vanellus vanellus)	BM		BM	M		BM	Kiebitz	Kievit	Charadriiformes	Charadriidae
57	Knot (Calidris canutus)	M	M	M	M	M	M	Knutt	Kanoetstrandloper	Charadriiformes	Scolopacidae
58	Sanderling (Calidris alba)	M	M	M	M	M	M	Sanderling	Drieteenstrandloper	Charadriiformes	Scolopacidae
59	Curlew Sandpiper (Calidris ferruginea)	M		M	M		M	Sichelstrandläufer	Krombekstrandloper	Charadriiformes	Scolopacidae
60	Dunlin (Calidris alpina)	BM	M	M	M	BM	BM	Alpenstrandläufer	Bonte Strandloper	Charadriiformes	Scolopacidae
61	Ruff (Philomachus pugnax)	BM	M	M		BM	BM	Kampfläufer	Kemphaan	Charadriiformes	Scolopacidae
62	Common Snipe (Gallinago gallinago)	BM		B			B	Bekassine	Watersnip	Charadriiformes	Scolopacidae
63	Black-tailed Godwit (Limosa limosa)	BM		BM	M		BM	Uferschnepfe	Grutto	Charadriiformes	Scolopacidae
64	Bar-Tailed Godwit (Limosa lapponica)	M		M	M	M	M	Pfuhlschnepfe	Rosse Grutto	Charadriiformes	Scolopacidae
65	Whimbrel (Numenius phaeopus)	M		M			M	Regenbrachvogel	Regenwulp	Charadriiformes	Scolopacidae
66	Eurasian Curlew (Numenius arquata)	BM	M	BM	M	BM	BM	Großer Brachvogel	Wulp	Charadriiformes	Scolopacidae
67	Spotted Redshank (Tringa erythropus)	M		M	M		M	Dunkelwasserläufer	Zwarte Ruiter	Charadriiformes	Scolopacidae
68	Common Redshank (Tringa totanus)	BM		BM	M	BM	BM	Rotschenkel	Tureluur	Charadriiformes	Scolopacidae
69	Greenshank (Tringa nebularia)	M		M	M	M	M	Grünschenkel	Groenpootruiter	Charadriiformes	Scolopacidae
70	Wood Sandpiper (Tringa glareola)		M					Bruchwaserläufer	Bosruiter	Charadriiformes	Scolopacidae

71	Turnstone (Arenaria interpres)	BM		M	M		BM	Steinwälzer	Steenloper	Charadriiformes	Scolopacidae
72	Red-Necked Phalarope (Phalaropus lobatus)		M					Odinshühnchen	Grauwe Franjepoot	Charadriiformes	Scolopacidae
73	Mediterranean Gull (Larus melanocephalus)	B					B	Schwarzkopfmöwe	Zwartkopmeeuw	Charadriiformes	Laridae
74	Little Gull (Larus minutus)	BM			M	B	B	Zwergmöwe	Dwergmeeuw	Charadriiformes	Laridae
75	Black-headed Gull (Larus ridibundus)	BM		M			BM	Lachmöwe	Kokmeeuw	Charadriiformes	Laridae
76	Common Gull (Larus canus)	BM		M			BM	Sturmmöwe	Stormmeeuw	Charadriiformes	Laridae
77	Lesser Black-backed Gull (Larus fuscus)	BM		M	B		BM	Heringsmöwe	Kleine Mantelmeeuw	Charadriiformes	Laridae
78	Herring Gull (Larus argentatus)	BM		M			BM	Silbermöwe	Zilvermeeuw	Charadriiformes	Laridae
79	Great Black-backed Gull (Larus marinus)	BM		M			BM	Mantelmöwe	Grote Mantelmeeuw	Charadriiformes	Laridae
80	Kittiwake (Larus tridactylus)	M						Dreizehenmöwe	Drieteenmeeuw	Larus tridactylus	Laridae
81	Gull-billed Tern (Gelochelidon nilotica)	B		B		B	B	Lachseeschwalbe	Lachstern	Charadriiformes	Sternidae
82	Sandwich tern (Sterna sandvicensis)	BM	BM	BM	B	BM	B	Brandseeschwalbe	Grote Stern	Charadriiformes	Sternidae
83	Common Tern (Sterna hirundo)	BM	BM	BM	B	BM	B	Flußseeschwalbe	Visdief	Charadriiformes	Sternidae
84	Arctic Tern (Sterna paradisaea)	BM	BM	BM	B	BM	B	Küstenseeschwalbe	Noordse Stern	Charadriiformes	Sternidae
85	Little Tern (Sterna albifrons)	BM	BM	BM	B	BM	B	Zwergseeschwalbe	Dwergstern	Charadriiformes	Sternidae
86	Black Tern (Chlidonias niger)	B	M		M	B		Trauerseeschwalbe	Zwarte Stern	Charadriiformes	Sternidae
87	Guillemot (Uria aalge)	M						Trottellumme	Zeekoet	Charadriiformes	Alcidae
88	Razorbill (Alca torda)	M						Tordalk	Alk	Charadriiformes	Alcidae
89	Short-eared Owl (Asio flammeus)	B	B	B	B	BM	B	Sumpfohreule	Velduil	Strigiformes	Strigidae
90	Kingfisher (Alcedo atthis)							Eisvogel	Ijsvogel	Coraciiformes	Alcedinidae
91	Wood Lark (Lullula arborea)		M					Heidelerche	Boomleeuwerik	Passeriformes	Alaudidae
92	Sky Lark (Alauda arvensis)			B				Feldlerche	Veldleeuwerik	Passeriformes	Alaudidae
93	Shore (Horned) Lark (Eremophila alpestris)						M	Ohrenlerche	Strandleeuwerik	Passeriformes	Alaudidae
94	Meadow Pipit (Anthus pratensis)							Wiesenpieper	Graspieper	Passeriformes	Motacillidae
95	Blue-Headed Wagtail (Motacilla flava)			B				Schafstelze	Gele Kwikstaart	Passeriformes	Motacillidae
96	Bluethroat (Luscinia svecica)	B		B		B		Blaukelchen	Blauwborst	Passeriformes	Muscicapidae
97	Whinchat (Saxicola rubetra)			B	B			Braunkehlchen	Paapje	Passeriformes	Muscicapidae
98	Stonechat (Saxicola torquata)				B			Schwarzkehlchen	Roodborsttapuit	Passeriformes	Muscicapidae
99	Wheatear (Oenanthe oenanthe)			B	B			Steinschmätzer	Tapuit	Passeriformes	Muscicapidae
100	Savi's Warbler (Locustella luscinioides)			B				Rohrschwirl	Snor	Passeriformes	Sylviidae
101	Sedge Warbler (Acrocephalus schoenobaenus)			B	B			Schilfrohrsänger	Rietzanger	Passeriformes	Sylviidae
102	Red-Breasted Flycatcher (Ficedula parva)		M					Zwergschnäpper	Kleine Vliegenvanger	Passeriformes	Muscicapidae (Muscicapinae)
103	Bearded Tit (Panurus biarmicus)							Bartmeise	Baardmannetje	Passeriformes	Timaliidae
104	Red-Backed Shrike (Lanius collurio)				B			Neuntöter	Grauwe Klauwier	Passeriformes	Laniidae
105	Twite (Carduelis flavirostris)						M	Berghänfling	Frater	Passeriformes	Fringillidae
106	Snow Bunting (Plectrophenax nivalis)						M	Schneeammer	Sneeuwgors	Passeriformes	Emberizidae

Annex 06

List of endemic saltmarsh species

List of endemic saltmarsh species

The table below lists 271 endemic species in the saltmarshes of the nominated property. A selection of a bibliography in English language with regard to the endemites is given for further information.

ANDRESEN, H., BAKKER, J.P., BRONGERS, M., HEYDEMANN, B. & IRMLER, U. (1990): Long-term changes of salt marsh communities by cattle grazing. Vegetatio, 89, 137-148.

DESENDER, K. (1985): Wing polymorphism and reproductive biology in the halobiont Carabid-Beetle Pogonus chalceus (Marsham) (Coleoptera, Carabidae). Biol. Jb. Dodonaea 53, 89-100.

FOSTER, W.A. & TREHERNE, J.E. (1975): The distribution of an intertidal Aphid, Pemphigus trehernei FOSTER, on marine saltmarshes.-Oecologia 21, 141-155.

FOSTER, W.A. (1983): Activity rhythms and the tide in a saltmarsh beetle Dicheirotrichus gustavi. Oecologia 60, 111-113.

HEMMINGA, M.A.und VAN SOELEN, J. (1988): Estuarine gradients and the growth and development of Agapanthia villosoviridescens (Coleptera), a stem-borer of the salt marsh halophyte Aster tripolium. Oecologia 77, 307-312.

MEYER, H. , FOCK, H., HAASE, A., REINKE, H.-D. & TULOWITZKI,I. (1995): Structure of the invertebrate fauna in salt marshes of the Wadden Sea coast of Schleswig-Holstein influenced by sheep-grazing. - Helgoländer Meeresuntersuchungen 49: 563-589; Hamburg. [D: SH; eco]

REINKE, H.-D., MEYER, H. (1999): Monitoring of the evertebrate fauna in Wadden Sea salt marshes. - Senckenbergiana Maritima 29 (Supplement): 127-133., Frankfurt am Main.

SOELEN, J., VAN & MARKUSSE, M.M. (1983): Notes on the distribution of some insect species in the stems of Aster tripolium L (Compositae). - Ent. Berichten Amsterdam 43: 124-127.

WYATT, T.D. & FOSTER, W.A. (1988): Distribution and abundance of the intertidal saltmarsh beetle Bledius spectabilis. - Ecological Entomology 13: 453-464.

Order	Family	Species	Salt-typ
Gastropoda		Assiminea grayana (Fleming)	hal-1
Gastropoda		Hydrobia ulvae (Pennant)	hal-1
Gastropoda		Limapontia capitata Müller	hal-1
Gastropoda		Ovatella myosotis (Draparnaud)	hal-1
Crustacea		Corophium volutator (Pallas)	hal-1
Crustacea		Orchestia gammarellus Pallas	hal-1
Oribatei	Oribatei	Ameronothrus nigrofemoratus	hal-1
Oribatei	Oribatei	Ameronothrus schneideri (Oudemanns)	hal-1
Oribatei	Oribatei	Hermannia subglabra Berlese	hal-1
Oribatei	Oribatei	Oribatella arctica litoralis Strenzke	hal-1
Oribatei	Oribatei	Punctoribates quadrivertex (Halbert)	hal-1
Gamasina	Gamasina	Leioseicus salinus (Halbert)	hal-1
Gamasina	Gamasina	Parasitus trouessarti (Berlese)	hal-1
Gamasina	Gamasina	Dendrolaelaps halophilus (Willmann)	hal-1
Collembola	Collembola	Archisotoma pulchella (Moniez)	hal-1
Collembola	Collembola	Folsomia sexoculata (Tullberg)	hal-1
Collembola	Collembola	Isotoma maritima (Tullberg)	hal-1
Collembola	Collembola	Onychiurus debilis (Moniez)	hal-1
Araneae	Dictynidae	Argenna patula Simon	hal-1
Araneae	Linyphiidae	Allomengea scopigera	hal-2
Araneae	Linyphiidae	Baryphyma duffeyi (Millidge)	hal-1
Araneae	Linyphiidae	Ceratinopsis sativa (Simon)	hal-2
Araneae	Linyphiidae	Erigone arctica (White)	hal-2
Araneae	Linyphiidae	Erigone longipalpis (Sundevall)	hal-2
Araneae	Linyphiidae	Erigone vagans (Audouin)	hal-2
Araneae	Linyphiidae	Hypomma bituberculatum (Wider)	hal-3
Araneae	Linyphiidae	Hypselistes jacksoni (O.P.Cambridge)	hal-2
Araneae	Linyphiidae	Oedothorax retusus (Westring)	hal-2
Araneae	Linyphiidae	Porrhomma microphthalmum (O.P.Cambridge)	hal-2
Araneae	Linyphiidae	Silometopus ambiguus (O.P.Cambridge)	hal-1
Araneae	Linyphiidae	Silometopus curtus (Simon)	hal-1-2
Araneae	Linyphiidae	Silometopus incurvatus (O.P.Cambridge)	hal-1
Araneae	Linyphiidae	Silometopus reussi (Thorell)	hal-2
Araneae	Linyphiidae	Walckenaeria vigilax (Blackwell)	hal-2
Araneae	Lycosidae	Pardosa purbeckesis (O.P.Cambridge)	hal-1
Araneae	Theridiidae	Robertus heydemanni Wiehle	hal-1
Araneae	Theridiidae	Enoplognatha mordax (Thorell)	hal-2
Araneae	Thomisidae	Ozyptila westringi	hal-1
Coleoptera	Apionidae	Pseudaplemonus limonii Kirby	hal-1
Coleoptera	Cantharidae	Cantharis fulvicillis F.	hal-2
Coleoptera	Cantharidae	Cantharis rufa var. darwiniana Sharp.	hal-1
Coleoptera	Carabidae	Acupalpus elegens (Dejean)	hal-1
Coleoptera	Carabidae	Agonum monachum (Duftschmidt) [= atratum Dufts.]	hal-1
Coleoptera	Carabidae	Amara convexiuscula (Marsham)	hal-2
Coleoptera	Carabidae	Amara ingenua (Duftschmid)	hal-2
Coleoptera	Carabidae	Amara strenua Zimmermann	hal-1
Coleoptera	Carabidae	Anisodactylus poeciloides (Stephens)	hal-1
Coleoptera	Carabidae	Bembidion aeneum Germar	hal-1
Coleoptera	Carabidae	Bembidion ephippium Germar	hal-1
Coleoptera	Carabidae	Bembidion fumigatum Duftschmidt	hal-2
Coleoptera	Carabidae	Bembidion iricolor Bedel	hal-1
Coleoptera	Carabidae	Bembidion lunatum (Duftschmid)	hal-2-3
Coleoptera	Carabidae	Bembidion lunulatum (Geoffroy)	hal-2-3
Coleoptera	Carabidae	Bembidion maritimum (Stephens)	hal-2
Coleoptera	Carabidae	Bembidion minimum (Fabricius) [= Bembidion pusillum Gyllenhal]	hal-2
Coleoptera	Carabidae	Bembidion normannum Dejean	hal-1
Coleoptera	Carabidae	Bembidion pallidipenne (Illiger)	hal-1

Coleoptera	Carabidae	Bembidion cruciatum polonicum Müller	hal-2
Coleoptera	Carabidae	Bembidion saxatile Gyllenhal	hal-2
Coleoptera	Carabidae	Bembidion tenellum Erichson	hal-1
Coleoptera	Carabidae	Cicindela maritima Dejean	hal-1
Coleoptera	Carabidae	Cillenus lateralis (Leach)	hal-1
Coleoptera	Carabidae	Dicheirotrichus gustavii Crotch	hal-1
Coleoptera	Carabidae	Dyschirius chalceus Erichson	hal-1
Coleoptera	Carabidae	Dyschirius impunctipennis Dawson	hal-2
Coleoptera	Carabidae	Dyschirius obscurus Gyllenhal	hal-2
Coleoptera	Carabidae	Dyschirius salinus Schaum	hal-1
Coleoptera	Carabidae	Pogonus chalceus (Marsham)	hal-1
Coleoptera	Carabidae	Pogonus luridipennis (Germar)	hal-1
Coleoptera	Carabidae	Tachys scutellaris Stephens	hal-1
Coleoptera	Carabidae	Tachys scutellaris Stephens	hal-1
Coleoptera	Cerambycidae	Agapanthia víllosoviridescens (de Geer)	hal-2-3
Coleoptera	Chrysomelidae	Longitarsus plantagomaritimus Degeer	hal-1
Coleoptera	Chrysomelidae	Phaedon concinnus Stephens	hal-1
Coleoptera	Coccinellidae	Coccinellia undecimpunctata tripunctata Linne	hal-2
Coleoptera	Curculionidae	Limnobaris dolorosa (Goeze) (= pilistriata Steph.)	hal-2-3
Coleoptera	Curculionidae	Mecinus collaris Germar	hal-2
Coleoptera	Curculionidae	Pelenomus zumpti Wagner	hal-1
Coleoptera	Curculionidae	Polydrusus pulchellus Stephens	hal-1
Coleoptera	Curculionidae	Trichosirocalus thalhammeri (Grenier)	hal-1
Coleoptera	Heteroceridae	Heterocerus flexuosus Stephens	hal-1
Coleoptera	Heteroceridae	Heterocerus fossor Kiesenwetter	hal-1
Coleoptera	Heteroceridae	Heterocerus hispidulus	hal-2-3
Coleoptera	Heteroceridae	Heterocerus maritimus Guérin	hal-1
Coleoptera	Hydraenidae	Ochthebius auriculatus Rey	hal-1
Coleoptera	Hydraenidae	Ochthebius dilatatus Stephens	hal-1
Coleoptera	Hydraenidae	Ochthebius marinus (Paykull)	hal-1
Coleoptera	Hydrophilidae	Cercyon depressus (Stephens)	hal-1
Coleoptera	Hydrophilidae	Cercyon litoralis (Gyllenhal)	hal-1
Coleoptera	Hydrophilidae	Enochrus bicolor (F.)	hal-2
Coleoptera	Malachiidae	Anthocomus coccineus (Schaller) [= rufus Herbst]	hal-2
Coleoptera	Ptiliidae	Ptenidium fuscicorne Erichson	hal-2
Coleoptera	Scirtidae	Cyphon laevipennis Tournier [= phragmiteticola Nyholm]	hal-2
Coleoptera	Staphylinidae	Amischa analis Gray.	hal-2-3
Coleoptera	Staphylinidae	Atheta orbata (Erichson)	hal-2-3
Coleoptera	Staphylinidae	Atheta vestita Gray.	hal-1
Coleoptera	Staphylinidae	Bledius bicornis (Germar)	hal-1
Coleoptera	Staphylinidae	Bledius opacus (Block)	hal-2-3
Coleoptera	Staphylinidae	Bledius spectabilis Kraatz	hal-1
Coleoptera	Staphylinidae	Bledius tricornis (Herbst)	hal-1-2
Coleoptera	Staphylinidae	Brundinia marina (Mulsant & Rey) [= Atheta]	hal-1
Coleoptera	Staphylinidae	Cafius xantholoma Gravenhorst	hal-1
Coleoptera	Staphylinidae	Carpelimus foveolatus (Sahlberg)	hal-2
Coleoptera	Staphylinidae	Carpelimus halophilus (Kiesenwetter)	hal-2
Coleoptera	Staphylinidae	Carpelimus schneideri (Gangelbauer)	hal-1-2
Coleoptera	Staphylinidae	Diglotta submarina Faim.& Lab.	hal-1
Coleoptera	Staphylinidae	Halobrecta flavipes Thompson	hal-1
Coleoptera	Staphylinidae	Halobrecta puncticeps (Thompson)	hal-1
Coleoptera	Staphylinidae	Micralymma marinum (Ström)	hal-1
Coleoptera	Staphylinidae	Omalium riparium Thompson	hal-1
Coleoptera	Staphylinidae	Oxypoda brachyptera (Stephens)	hal-2-3
Coleoptera	Staphylinidae	Oxypoda exoleta Erichson [= bavaria, hütheri Scheerp.]	hal-2
Coleoptera	Staphylinidae	Quedius simplicifrons Fairmaire [= hispanicus Bernhauer]	hal-1
Coleoptera	Staphylinidae	Tomoglossa heydemanni Lohse	hal-1
Lepidoptera	Cochylidae	Phalonidia affinitana (Douglas)	hal-1
Lepidoptera	Cochylidae	Phalonidia vectisana (Humphreys & Westwood)	hal-2

Lepidoptera	Coleophoridae	Coleophora adjunctella Hodkinson	hal-1
Lepidoptera	Coleophoridae	Coleophora artemisiella Scott	hal-2
Lepidoptera	Coleophoridae	Coleophora asteris Mühlig	hal-1
Lepidoptera	Coleophoridae	Coleophora atriplicis Meyrick	hal-1
Lepidoptera	Coleophoridae	Coleophora moeniacella Stainton	hal-1
Lepidoptera	Coleophoridae	Coleophora salicorniae Wocke	hal-1
Lepidoptera	Coleophoridae	Coleophora simillimella Fuchs	hal-2
Lepidoptera	Coleophoridae	Coleophora suaedivora Meyrick	hal-1
Lepidoptera	Coleophoridae	Goniodoma limoniella	hal-1
Lepidoptera	Elachistidae	Elachista scirpi (Stainton)	hal-1
Lepidoptera	Gelechiidae	Aristotelia brizella	hal-2
Lepidoptera	Gelechiidae	Monochroa tetragonella (Stainton)	hal-1
Lepidoptera	Gelechiidae	Scrobipalpa instabiella (Douglas)	hal-1
Lepidoptera	Gelechiidae	Scrobipalpa nitentella (Fuchs)	hal-1
Lepidoptera	Gelechiidae	Scrobipalpa obsoletella (F. v. Röslerstamm)	hal-2
Lepidoptera	Gelechiidae	Scrobipalpa plantaginella	hal-1
Lepidoptera	Gelechiidae	Scrobipalpa salinella	hal-1
Lepidoptera	Gelechiidae	Scrobipalpa samadensis (Pfaff.)	hal-1
Lepidoptera	Gelechiidae	Scrobipalpa strangei (E. Hering)	hal-1
Lepidoptera	Gelechiidae	Xystophora gudmanni Larsen	hal-1
Lepidoptera	Geometridae	Scopula emutaria Hbn. [= Acidalia emutaria]	hal-1
Lepidoptera	Lyonetiidae	Bucculatrix maritima (Stainton)	hal-1
Lepidoptera	Noctuidae	Apamea oblonga (Hayworth)	hal-2
Lepidoptera	Noctuidae	Amphipoea (Mythimna) fucosa (Freyer)	hal-2
Lepidoptera	Noctuidae	Mythimna favicolor (Barret)	hal-1
Lepidoptera	Pterophoridae	Agdistis benneti Curt.	hal-1
Lepidoptera	Pyralidae	Pediarsia aridella (Thenberg)	hal-1
Lepidoptera	Tortricidae	Bactra robustana (Christoph)	hal-1
Lepidoptera	Tortricidae	Eucosoma krygeri Rebel	hal-1
Lepidoptera	Tortricidae	Eucosoma maritima (Humphreys & Westwood)	hal-2
Lepidoptera	Tortricidae	Eucosoma tripoliana (Barret)	hal-1
Lepidoptera	Tortricidae	Lobesia litoralis (Humphreys & Westwood)	hal-2
Rhynchota-Aphidoidea	Aphididae	Aphis tripolii Laing, 1920	hal-1
Rhynchota-Aphidoidea	Aphididae	Chaitaphis suaedae (Mimeur)	hal-1
Rhynchota-Aphidoidea	Aphididae	Coloradoa (Lidaja) heizei (Börner, 1952) / Börner, 1952	hal-1
Rhynchota-Aphidoidea	Aphididae	Hayhurstia atriplicis	hal-2
Rhynchota-Aphidoidea	Aphididae	Macrosiphoniella asteris (Walker, 1849)	hal-1
Rhynchota-Aphidoidea	Aphididae	Macrosiphoniella pulvera (Walker, 1848)	hal-1
Rhynchota-Aphidoidea	Aphididae	Staticobium limonii (Contarini, 1847)	hal-1
Rhynchota-Aphidoidea	Callaphididae	Juncobia leegei (Börner, 1930)	hal-2
Rhynchota-Aphidoidea	Chaitophoridae	Atheroides brevicornis Laing	hal-2
Rhynchota-Aphidoidea	Chaitophoridae	Sipha litoralis (Walker)	hal-1
Rhynchota-Aphidoidea	Pemphigidae	Geoica utricularia (Passerini, 1856) sensu Mordvilko, 1935	hal-1
Rhynchota-Aphidoidea	Pemphigidae	Aploneura lentisci (Passerini)	hal-2
Rhynchota-Aphidoidea	Pemphigidae	Pemphigus trehernei Foster	hal-1
Diptera-Nematocera	Cecidomyiidae	Jaapiella schmidti (RÜBSAAMEN, 1912)	hal-1
Diptera-Nematocera	Cecidomyiidae	Mayetiola agrostivora MEYER, 1985	hal-2

Diptera-Nematocera	Cecidomyiidae	Mayetiola puccinelliae MEYER, 1980	hal-1
Diptera-Nematocera	Cecidomyiidae	Procystiphora gerardii MEYER, 1980	hal-1
Diptera-Nematocera	Cecidomyiidae	Rhopalomyia florum (KIEFFER, 1890)	hal-1
Diptera-Nematocera	Limoniidae	Symplecta hybrida (Meigen)	hal-2
Diptera-Nematocera	Limoniidae	Symplecta stictica (Meigen)	hal-1-2
Diptera-Brachycera	Agromyzidae	Amauromyza luteiceps (HENDEL, 1920)	hal-1
Diptera-Brachycera	Agromyzidae	Cerodontha fasciata (STROBL, 1880)	hal-1
Diptera-Brachycera	Agromyzidae	Cerodontha suturalis (HENDEL, 1931)	hal-1
Diptera-Brachycera	Agromyzidae	Chromatomyia asteris (= Phytomyza) (HENDEL, 1934)	hal-1
Diptera-Brachycera	Agromyzidae	Liriomyza angulicornis (MALLOCH, 1918)	hal-1
Diptera-Brachycera	Agromyzidae	Liriomyza cicerina (RONDANI, 1875)	hal-2
Diptera-Brachycera	Agromyzidae	Liriomyza gudmanni HERING, 1928	hal-1
Diptera-Brachycera	Agromyzidae	Liriomyza latipalpis HENDEL, 1920	hal-1
Diptera-Brachycera	Agromyzidae	Melanagromyza tripolii SPENCER, 1957	hal-1
Diptera-Brachycera	Agromyzidae	Metopomyza junci VON TSCHIRNHAUS, 1981	hal-1
Diptera-Brachycera	Agromyzidae	Napomyza maritima VON TSCHIRNHAUS, 1981	hal-1
Diptera-Brachycera	Agromyzidae	Napomyza tripolii SPENCER, 1966	hal-1
Diptera-Brachycera	Agromyzidae	Ophiomyia ononidis SPENCER, 1966	hal-2
Diptera-Brachycera	Agromyzidae	Phytomyza euphrasiae KALTENBACH, 1860	hal-2
Diptera-Brachycera	Agromyzidae	Phytomyza isais HERING, 1936	hal-2
Diptera-Brachycera	Agromyzidae	Phytomyza plantaginis ROBIN.-DESVOIDY, 1851	hal-1
Diptera-Brachycera	Anthomyiidae	Pegomya betae atriplicis (CURTIS, 1847)	hal-1
Diptera-Brachycera	Chloropidae	Aphanotrigonum fasciellum (ZETTERSTEDT, 1855)	hal-1
Diptera-Brachycera	Chloropidae	Aphanotrigonum femorellum COLLIN, 1946	hal-1
Diptera-Brachycera	Chloropidae	Aphanotrigonum femorellum COLLIN, 1946	hal-1
Diptera-Brachycera	Chloropidae	Chlorops calceatus MEIGEN, 1830	hal-1
Diptera-Brachycera	Chloropidae	Dicraeus fennicus DUDA, 1933	hal-1
Diptera-Brachycera	Chloropidae	Elachiptera cornuta (FALLÉN, 1820)	hal-1
Diptera-Brachycera	Chloropidae	Eribolus slesvicensis BECKER, 1910	hal-1
Diptera-Brachycera	Chloropidae	Eurina lurida MEIGEN, 1830	hal-1
Diptera-Brachycera	Chloropidae	Incertella (= Tropidoscinis) junci n.sp. VON TSCHIRNHAUS, 1981	hal-1

Diptera-Brachycera	Chloropidae	Incertella (= Tropidoscinis) triglochinidis n.sp. VON TSCHIRNHAUS, 1981	hal-1
Diptera-Brachycera	Chloropidae	Melanum laterale (HALIDAY, 1833)	hal-1
Diptera-Brachycera	Chloropidae	Meromyza nigriventris MACQUART, 1835	hal-2
Diptera-Brachycera	Chloropidae	Meromyza puccinelliae n.sp. VON TSCHIRNHAUS, 1981	hal-1
Diptera-Brachycera	Chloropidae	Microcercis (= Tropidoscinis] zuercheri (DUDA, 1933)	hal-1
Diptera-Brachycera	Chloropidae	Microcercis trigonella (= Oscinella) (DUDA, 1933)	hal-1
Diptera-Brachycera	Chloropidae	Oscinimorpha albisetosa (DUDA, 1932)	hal-1
Diptera-Brachycera	Chloropidae	Oscinimorpha albisetosa (DUDA, 1932)	hal-1
Diptera-Brachycera	Chloropidae	Pseudopachychaeta approximatonervis (ZETTERSTEDT, 1848)	hal-1
Diptera-Brachycera	Dolichopodidae	Aphrosylus mitis Verrall, 1912	hal-1
Diptera-Brachycera	Dolichopodidae	Asyndetus longicornis Negrobov, 1973	hal-1
Diptera-Brachycera	Dolichopodidae	Campsicnemus armatus (Zetterstedt, 1849)	hal-2
Diptera-Brachycera	Dolichopodidae	Campsicnemus magius (Loew, 1845)	hal-1
Diptera-Brachycera	Dolichopodidae	Dolichopus clavipes Haliday, 1832	hal-1
Diptera-Brachycera	Dolichopodidae	Dolichopus diadema Haliday, 1832	hal-1
Diptera-Brachycera	Dolichopodidae	Dolichopus latipennis Fallén, 1823	hal-2
Diptera-Brachycera	Dolichopodidae	Dolichopus plumipes (Scopoli, 1763)	hal-2-3
Diptera-Brachycera	Dolichopodidae	Dolichopus sabinus Haliday, 1838	hal-1
Diptera-Brachycera	Dolichopodidae	Dolichopus signifer Haliday, 1838	hal-2
Diptera-Brachycera	Dolichopodidae	Dolichopus strigipes Verrall, 1875	hal-2
Diptera-Brachycera	Dolichopodidae	Hydrophorus oceanus (Macquart, 1838)	hal-1
Diptera-Brachycera	Dolichopodidae	Hydrophorus praecox (Lehmann, 1822)	hal-2
Diptera-Brachycera	Dolichopodidae	Machaerium maritimae Haliday, 1832	hal-1
Diptera-Brachycera	Dolichopodidae	Medetera micacea Loew, 1857	hal-2-3
Diptera-Brachycera	Dolichopodidae	Melanostolus nigricilius (Loew, 1871)	hal-2
Diptera-Brachycera	Dolichopodidae	Micromorphus albipes (Zetterstedt, 1843)	hal-1-2
Diptera-Brachycera	Dolichopodidae	Muscidideicus praetextatus (Haliday, 1855)	hal-1
Diptera-Brachycera	Dolichopodidae	Orthoceratium lacustre (Scopoli, 1763)	hal-1
Diptera-Brachycera	Dolichopodidae	Poecilobothrus regalis (Meigen, 1824)	hal-2
Diptera-Brachycera	Dolichopodidae	Rhaphium consobrinum Zetterstedt, 1843	hal-2
Diptera-Brachycera	Dolichopodidae	Rhaphium riparium (Meigen, 1824)	hal-1-2

Diptera-Brachycera	Dolichopodidae	Schoenophilus versutus (Haliday, 1851)	hal-2
Diptera-Brachycera	Dolichopodidae	Sciapus maritimus Becker, 1918	hal-1
Diptera-Brachycera	Dolichopodidae	Sympycnus desoutteri Parent, 1925	hal-2-3
Diptera-Brachycera	Dolichopodidae	Syntormon filiger Verrall, 1912	hal-2
Diptera-Brachycera	Dolichopodidae	Syntormon pallipes (Fabricius, 1794)	hal-2-3
Diptera-Brachycera	Dolichopodidae	Syntormon rufipes	hal-2
Diptera-Brachycera	Dolichopodidae	Thinophilus flavipalpis (Zetterstedt, 1843)	hal-1
Diptera-Brachycera	Dolichopodidae	Thinophilus ruficornis (Haliday, 1838)	hal-1-2
Diptera-Brachycera	Empididae	Hilara lundbecki Frey, 1913	hal-1
Diptera-Brachycera	Empididae	Rhamphomyia (Pararhamphomyia) simplex Zetterstedt, 1849	hal-1
Diptera-Brachycera	Hybotidae	Chersodromia cursitans (Zetterstedt, 1819)	hal-2
Diptera-Brachycera	Hybotidae	Chersodromia speculifera Walker, 1851	hal-1
Diptera-Brachycera	Hybotidae	Crossopalpus curvipes (Meigen, 1822)	hal-2
Diptera-Brachycera	Hybotidae	Stilpon nubilus Collin, 1926	hal-2
Diptera-Brachycera	Stratiomyidae	Nemotelus notatus Zetterstedt	hal-1
Diptera-Brachycera	Stratiomyidae	Nemotelus uliginosus (Linne)	hal-1
Diptera-Brachycera	Syrphidae	Eristalinus sepulchralis (L.)	hal-1
Diptera-Brachycera	Syrphidae	Lathyrophthalmus aeneus	hal-1
Diptera-Brachycera	Tephritidae	Ensina sonchi (LINNÉ, 1767)	hal-1
Diptera-Brachycera	Tephritidae	Paroxyna plantaginis (HALIDAY, 1883)	hal-1
Heteroptera	Miridae	Exolygus maritimus Wagner	hal-2
Heteroptera	Miridae	Conostethus frisicus Wagner	hal-1
Heteroptera	Miridae	Melanotrichus moncreaffi D.Sc. [Ortholygus]	hal-1
Heteroptera	Miridae	Melanotrichus rubidus (Puton) [Ortholygus]	hal-1
Heteroptera	Miridae	Poliopterus litoralis Wagner [Plagiognathus]	hal-1
Heteroptera	Tingidae	Agramma confusa (Puton)	hal-1
Heteroptera	Saldidae	Chartoscirta elegantula (Fallen)	hal-2-3
Heteroptera	Saldidae	Chiloxanthus pilosus (Fallen)	hal-1-2
Heteroptera	Saldidae	Chiloxanthus setulosus	hal-1-2
Heteroptera	Saldidae	Halosalda lateralis (Fallen)	hal-1
Heteroptera	Saldidae	Salda littoralis (Linne)	hal-2-3
Heteroptera	Saldidae	Saldula pallipes (Fabricius)	hal-2-3
Heteroptera	Saldidae	Saldula palustris (Douglas & Scott)	hal-1
Heteroptera	Saldidae	Saldula pilosella (Thomson)	hal-2-3
Heteroptera	Saldidae	Saldula saltatoria (L.)	hal-2-3
Auchenorrhyncha	Cicadellidae	Anoscopus limicola (=Aphrodes li. W.Wa.37) (Edwards, 1908)	hal-1
Auchenorrhyncha	Cicadellidae	Arthaldeus pascuellus (Falle´n, 1826)	hal-2-3
Auchenorrhyncha	Cicadellidae	Cicadula (Cicadula) quadrinotata (Fabricius, 1794)	hal-2-3
Auchenorrhyncha	Cicadellidae	Conosanus obsoletus (Kirschbaum, 1858)	hal-2-3
Auchenorrhyncha	Delphacidae	Delphax pulchellus (Curtis, 1833)	hal-2-3

Auchenorrhyncha	Cicadellidae	Eupteryx artemisiae (Kirschbaum, 1868) [Poliopterus litoralis]	hal-1
Auchenorrhyncha	Cicadellidae	Macrosteles (Macrosteles) horvathi (W. Wagner, 1935)	hal-1-2
Auchenorrhyncha	Cicadellidae	Macrosteles (Macrosteles) sordidipennis (Stal, 1858)	hal-2
Auchenorrhyncha	Cicadellidae	Paramesus obtusifrons (Stal, 1853)	hal-1
Auchenorrhyncha	Cicadellidae	Psammotettix putoni (= Deltoc. halophilus Edw.24) (Then, 1898)	hal-1
Auchenorrhyncha	Cicadellidae	Stroggylocephalus agrestis (Falle´n, 1806)	hal-2-3

Annex 09

Bibliography

Bibliography

A list of main references for the nomination of the Dutch-German Wadden Sea as World Heritage Site is provided in this Annex.

Abt, K.F., 2002. Phänologie und Populationsdynamik des Seehundes Phoca vitulina im Wattenmeer: Grundlagen zur Messung von Statusparametern. Ph.D thesis, Universität Kiel. Büsum, Berichte des Forschungs- und Technologiezentrums der Universität Kiel Nr. 24, pp.117.

Abt, K.F., Hoyer, N., Koch, L. and Adelung, D., 2002. The dynamics of grey seals Halichoerus grypus off Amrum in the south-eastern North Sea - evidence of an open population. J. Sea Res. 47, 55–67.

Addink, M.J. and Smeenk, C., 1999. The harbour porpoise Phocoena phocoena in Dutch coastal waters: analysis of stranding records for the period 1920-1994. Lutra 41, 55-80.

Adolph, W., Jaklin, S., Meemken, M. and Michaelis, H., 2003. Die Seegrasbestände der niedersächischen Watten 2000-2002. Niedersächisches Landesamt Ökologie, Forschungsstelle Küste, Norderney, Germany.

Aken, H.M. van, 2003. 140 years of daily observations in a tidal inlet (Marsdiep). ICES Mar Sci Symp 219: 359-361.

Åkerman, J.E. and Smit, T., 2003. Effect directed assessment in the water phase of Wadden Sea and Ems-Dollard: a pilot study. (in Dutch). Internal document RIKZ/AB/2003.607x.

Åkerman, J.E., Klamer, J.C., Schipper, C., Bakker, J.F., Bellert, B. and Pijnenburg, A.M.C.M., 2004. Newly emerging compounds in the North Sea and Dutch Coastal Zone in 2003. (in Dutch, English summary). RIKZ report RIKZ/2004.040, December 2004.

Amterne Vadehavssamarbejde, 2003. Vadehavet 2002. Vandmiljø overvågning. Amternes Vadehavssamarbejde, Ribe Amt, Sønderjyllands Amt, Denmark, pp. 220.

Amterne Vadehavssamarbejde, 2004. Vadehavet 2003, Vandmiljø overvågning. Amternes Vadehavssamarbejde, Ribe Amt, Sønderjyllands Amt, Denmark, pp. 255.

Andresen, H., Bakker, J.P., Brongers, M., Heydemann, B. and Irmler, U., 1990. Long-term changes of salt marsh communities by cattle grazing. Vegetatio 89: 137-148.

Anonymous, 2003. Results Scientific Research EVA II – Public version. Ministerie van Landbouw, Natuur en Voedselkwaliteit, Directie Visserij, Den Haag pp. 37.

Armonies, W. and Reise, K., 1999. On the population development of the introduced razor clam Ensis americanus near the island of Sylt (North Sea). Helgoländer Meeresunters. 52, 291-300.

Armonies, W., 2001. What an introduced species can tell us about the spatial extension of benthic populations. Mar. Ecol. Prog. Ser. 209, 289-294.

Armonies, W., Herre, E. and Sturm, M., 2001. Effects of the severe winter 1995/96 on the benthic macrofauna of the Wadden Sea and the coastal North Sea near the island of Sylt. Helgol. Mar. Res. 55: 170-175.

Asbirk, S. and Pitter, E. (eds.), 2005. Handlingsplan for truede engfugle 2005. Skov- og Naturstyrelsen (also available online: www.skovognatur.dk).

Asmuth, J.R., von and Tolman, M., 1996. Schiermonnikoog, vegetatiekartering. Meetkundige Dienst, Rijkswaterstaat.

Atrill, M.J. and Power, M. 2002. Climatic influence on a marine fish assemblage. Nature 417: 275-278.

Austin, G. and Rehfisch, M.M., 2005. Shifting non-distributions of migratory fauna in relation to climate change. Global Change Biology 11, 31-38.

Averbeck, C., M. Korsch, G. Vauk & J. Wilke, 1993. Seevögel als Ölopfer.- Umweltbundesamt, Wasser Forschungsbericht 102 04 414, Norddeutsche Naturschutzakademie, pp. 58.

Bairlein, F. and Hüppop, O., 2004. Migratory fuelling and global climate change. Advances Ecol. Research 35, 33-47.

Bairlein, F. and Exo, K.-M., 2007. Climate change and migratory waterbirds in the Wadden Sea. In Reineking, B. and Südbeck, P. (Eds.). Seriously declining trends in migratory waterbirds: Causes-Concerns-Consequences. Proceedings of the International Workshop on 31 August 2006 in Wilhelmshaven, Germany. Wadden Sea Ecosystems No. 23. Common Wadden Sea Secretariat, Wadden Sea National Park of Lower Saxony, Institute of Avian Research, Joint Monitoring Group of Migratory Birds in the Wadden Sea, Wilhelmshaven, Germany, p. 43 – 52.

Bakker, C., 2005. Key process in restoration of wet dune slacks. Ph. D. thesis, Rijksuniversiteit Groningen, pp. 153.

Baker, J.M., 1983. Impact of Oil Pollution on Living Resources. The Environmentalist 3, Suppl. No. 4.

Bakker, J.F., Bartelds, W., Becker, P.H., Bester K., Dijkhuizen, D., Frederiks, B., Reineking, B., 1999. Marine Chemistry. In:, Jong, F. de, Bakker, J.F., van Berkel, C.J.M., Dankers, N.M.J.A., Dahl, K., Gätje, C., Marencic, H. and Potel, P. (Eds.), 1999 Wadden Sea Quality Status Report. Wadden Sea Ecosystem No. 9. Common Wadden Sea Secretariat, Trilateral Monitoring and Assessment Group, Quality Status Report Group. Wilhelmshaven.

Bakker, J.P., Esselink, P., Dijkema, K.S., van Duin, W.E. and de Jong, D.J., 2002. Restoration of salt marshes in The Netherlands. Hydrobiologia 478: 29-51.

Bakker, J.P., Bos, D., Stahl, J., de Vries, Y. and Jensen, A., 2003b. Biodiversität und Landnutzung in Salzwiesen. Nova Acta Leopoldina NF 87, 328: 163-194.

Bakker, J.P., D. Bos and De Vries, Y., 2003a. To graze or not to graze: that is the question. In: Wolff, W.J., Essink, K., Kellerman, A. and Van Leeuwe, M.A. (Eds.). Proceedings of the 10th International Scientific Wadden Sea Symposium, pp. 67-88. Ministry of Agriculture, Nature Management and Fisheries and Department of Marine Biology, University of Groningen.

Bakker, J.P., Kuijper, D.P.J., van Wijnen, H.J., de Groot, A.V. and de Vries, Y., 2004. Spatio-temporal variation in surface elevation changes in back barrier salt marshes in the Wadden Sea. Geografisk Tidsskrift (in press).

Bakker, J.P. and Piersma, T., 2005. Restoration of intertidal flats and tidal salt marshes. In: Restoration ecology. The New Frontier. Edited by Andel, J. van and Aronson, J., Blackwell Science, Oxford. pp. 174-192.

Bakker, N.J., 1998. Vegetatiekartering van natuurgebied Ameland. BuroBakker.

Bakker, N.J., 1999. Vegetatiekartering van natuurgebied Terschelling. BuroBakker.

Bakker, T.W.M., Klijn, J.A,. and Zadelhoff, F.J., van, 1979. Duinen en duinvalleien. Een landschapsoecologische studie van het Nederlandse duingebied. Pudoc, Wageningen.

Balzer, S., D. Boedecker and Hauke, U., 2002. Interpretation, Abgrenzung und Erfassung der marinen und Küstenlebensraumtypen nach Anhang I der FFH-Richtlinien in Deutschland. Natur und Landschaft 77 (1): 20-28.

Baptist, H.J.M. and Wolf, P.A., 1993. Atlas van de vogels van het Nederlands continentaal plat. Rapport DGW-93.012. Ministerie van Verkeer en Waterstaat.

Baptist H., 2005. Habitattoets proef weghalen oesterbanken in de Oosterschelde. Report No. 2005/19. Ecologisch Adviesbureau Henk Baptist, Kruisland.

Baretta, J. and Ruardij, P., 1988. Tidal Flat Estuaries. Ecological Studies, 71. Springer Verlag, Berlin. pp. 353.

Bartholdy, J., Christiansen, C. and Kunzendorf, H., 2004. Long term variations in backbarrier salt marsh deposition on the Skallingen peninsula - the Danish Wadden Sea. Marine Geology 203:1-21.

Beale, C.M. and Monaghan, P., 2004. Human disturbance: people as predation-free predators? – Journal of Applied Ecology 41, 335-343.

Béchet, A., Giroux, J.-F. and Gauthier, G., 2004. The effects of disturbance on behaviour, habitat use and energy of spring staging Snow Geese. - Journal of Applied Ecology 41, 689-700.

Becker, G.A. and Pauly, M., 1996. Sea surface temperature changes in the North Sea in relation to decadal North Sea variability. ICES J. Mar. Sci. 53: 887-898.

Becker, P. and Muñoz-Cifuentes, A., 2004. Contaminants in bird eggs: recent spatial and temporal trends 1991-2000. Wadden Sea Ecosystem No. 18: 5-25. Common Wadden Sea Secretariat, Trilateral Monitoring and Assessment Group, Wilhelmshaven.

Becker, P.H., Koepff, C., Heidmann, W.A. and Büthe, A. 1991. Schadstoffmonitoring mit Seevögeln. Forschungsbericht UBA-FB 91-081, TEXTE 2/92, Umweltbundesamt, Berlin.

Becker, P.H., Heidmann, W.A., Büthe, A., Frank, D. and Koepff, C., 1992. Umweltchemikalien in Eiern von Brutvögeln der deutschen Nordseeküste: Trends 1981 – 1990. J. Ornithol. 133, 109-124.

Becker, P.H., Munoz Cifuentes, J., Behrends, B. and Schmieder, K.R., 2001. Contaminants in bird eggs in the Wadden Sea. Temporal and spatial trends 1991 – 2000. Wadden Sea Ecosystem No. 11. Common Wadden Sea Secretariat, Trilateral Monitoring and Assessment Group, Wilhelmshaven, Germany, pp. 67.

Becker, P.H., Furness, R.W. and Tasker, M.L, 2003. Seabirds as monitors of marine pollution. In: Furness, R.W. and Tasker, M.L., (Eds.), Seabirds as monitors of the marine environment. ICES Coop. Res. Report No. 258: 3-25.

Beeftink, W.G., Daane. M.C., de Munck, W. and Nieuwenhuize, J., 1978. Aspects of population dynamics in *Halimione portulacoides*. Vegetatio 36: 31-43.

Beek, F.A. van, Rijnsdorp, A.D. and Clerck, R. de, 1989. Monitoring juvenile stocks of flatfish in the Wadden Sea and coastal areas of the southeastern North Sea. Helgoländer Meeresunters. 43, 461-477.

Belfroid, A, van Velzen, M, van der Horst, B., and Vethaak, D., 2002. Occurrence of bisphenol A in surface water and uptake in fish: evaluation of field measurements. Chemosphere 49: 97-103.

Bellert, E.G. and van de Ven, C.L.M., 2003. Survey on IRGAROL in the western Dutch Wadden Sea. RIKZ report RIKZ/AB/2003.615x. July 2003.

Bellert, E.G., Åkerman, J.E., Koopmans, M.P. and van de Ven, C.L.M., 2004. Anthropogenic inputs by shipping and atmospheric deposition into the Dutch Wadden Sea and Ems-Dollard. RIKZ report RIKZ/AB/2004.612. July, 2004; in Dutch.

Bennekom, A.J. van, and Wetsteijn, F.J., 1990. The winter distribution of nutrients in the southern bight of the North Sea (1961-1978) and in the estuaries of the Scheldt and the Rhine/Meuse. Neth. J. Sea Res. 25: 75-87.

Berghahn, R., 1996. Episodic mass invasions of juvenile gadoids into the Wadden Sea and their consequences for the population dynamics of brown shrimp (Crangon crangon). Mar. Ecol. 17 (1-3), 251-260.

Bergman, M.J.N., 1985. Behaviour and biological impact of (un)treated oil spills in estuarine areas. Neth. J. Agric. Sci. 33, 78-81.

Bergmann, H.H., Borbach-Jaene, J., 2001. Auswirkungen von Bewirtschaftungsänderungen auf die Habitatwahl, Raumnutzung und das Verhalten von Nonnengans und Ringelgans am Beispiel der Leybucht im Nationalpark Niedersächsisches Wattenmeer. Universität Osnabrück, AG Gänseforschung, Osnabrück.

Bergmann, H.H., Borbach-Jaene, J., Kruckenberg, H. and Weight. H., 2003. Die Leybucht: Kein Platz für Gänse?. Ein Forschungsprojekt zum Einfluss der Beweidung auf die rastenden Wildgänse in der Leybucht. Schriftenreihe Nationalpark Niedersächsisches Wattenmeer, Band 5, Nationalparkverwaltung Wilhelmshaven, pp. 40.

Berndt, R.K., Koop, B. and Struwe-Juhl, B., 2002. Vogelwelt Schleswig-Holsteins, Band 5, Brutvogelatlas. Wacholtz Verlag, Neumünster.

Berrevoets, C.M. and Arts, F.A., 2003. Midwintertelling van zee-eenden in de Waddenzee en Nederlandse kustwateren, Januari 2003. Rapport RIKZ/2003/008.

Beukema, J.J., Dörjes, J., Essink, K., 1988. Latitudinal differences in survival during a severe winter in macrozoobenthic species sensitive to low temperatures. Senckenbergiana marit. 20: 19-30.

Beukema, J.J. and Dekker, R., 1995. Dynamics and growth of a recent invader into European coastal waters: the American razor clam, *Ensis directus*. J. Mar. Biol. Ass. UK 75, 351-362.

Beukema, J.J., Hopkoop, P.J.C., Dekker, R., 1998. Recruitment in *Macoma balthica* after mild and cold winters and its possible control by egg production and shrimp predation. Hydrobiol. 375/376: 23-34.

Beukema, J.J. and Cadée, G.C., 1999. An estimate of sustainable rate of shell extraction from the Dutch Wadden Sea. J. Appl Ecol 36: 49-58.

Beukema, J.J., Dekker, R., Essink, K. and Michaelis, H., 2001. Synchronized reproductive success of the main bivalve species in the Wadden Sea: causes and consequences. Mar. Ecol. Progr. Ser. 211: 143-153.

Beukema, J.J., 2002. Expected changes in the benthic fauna of Wadden Sea tidal flats as a result of sea level rise or bottom subsidence. J. Sea. Res. 47: 25-39.

Beukema, J.J., Cadée, G.C. and Dekker, R., 2002. Zoobenthic biomass limited by phytoplankton abundance: evidence from parallel changes in two long-term data series in the Wadden Sea. J. Sea Res. 48: 111-125.

Beukema, J.J. and Dekker, R., 2003. Redistribution of spat-sized *Macoma balthica* in the Wadden Sea in cold and mild winters. Mar Ecol Progr Ser 265: 117-122.

Beukema, J.J. and Dekker, R., 2004. Decline of recruitment success in cockles and other bivalves in the Wadden Sea: possible role of climate change, predation on postlarvae and fisheries. Marine Ecology Progress Series 287, 149-167.

Beukema, J.J. and Dekker, R., 2005. Decline of recruitment success in cockles and other bivalves in the Wadden Sea: possible role of climate change, predation on postlarvae and fisheries. Mar. Ecol. Progr. Ser. 287, 149-167.

Beusekom, J. E. E. van, Fock, H., Jong, F. de, Diel-Christiansen, S., Christiansen, B., 2001. Wadden Sea Specific Eutrophication Criteria. Wadden Sea Ecosystem No. 14, Common Wadden Sea Secretariat, Wilhelmshaven, Germany, pp.115.

Beusekom, J.E.E. van, Elbrächter, M., Gaul, H., Goebel, J., Hanslik, M., Petenati, T., Wiltshire, K.H., 2004. Nährstoffe und Phytoplankton in der Deutschen Bucht in den Jahren 1999-2003. BLMP Jahresbericht 1999-2002.

Beusekom, J.E.E. van, 2005. Eutrophication history of the Wadden Sea. Helgoland Mar. Res 59: 5–54.

Bewirtschaftungsplan, 2004. Bewirtschaftungsplan Miesmuschelfischerei im Nationalpark "Niedersächsisches Wattenmeer". Niedersächsisches Ministerium für den ländlichen Raum, Ernährung, Landwirtschaft und Verbraucherschutz, Niedersächsisches Umweltministerium, Hannover, Juni 2004, pp. 8.

BfG, 2001. Bagger- und Klappstellenuntersuchungen im Ems-Ästuar. Klappstellen 1 bis 7. BfG-Koblenz, WSA-Emden, Bericht BfG-1329.

BirdLife International, 2004. Birds in Europe: population estimates, trends en conservation status. BirdLife International, Cambridge.

Blanchard, M., 1997. Spread of the slipper limpet Crepidula fornicata (L. 1758) in Europe: current state and consequences. Sci. Mar. 61, 109-118.

Bleeker, A. and Duyzer, J.H., 2002. Inputs of contaminants to the surface waters of the Sanitation Board of the Holland Islands and Forelands. TNO Report: R2002/231.

Blew, J., Günther K., Laursen, K., van Roomen, M., Südbeck, P., Eskildsen, K., Potel, P. and Rösner, H.U. (eds.), 2005. Overview of Numbers and Trends of Migratory Waterbirds in the Wadden Sea 1980-2000. Wadden Sea Ecosystem No. 20, Common Wadden Sea Secretariat, Trilateral Monitoring and Assessment Group, Joint Monitoring Group of Migratory Birds in the Wadden Sea, Wilhelmshaven, FRG.

BMU 2002. Strategie der Bundesregierung zur Windenergienutzung auf See Stand: Januar 2002.

Boddeke, R., Clerck, R. de, Daan, N., Müller, A., Postuma, K.H., Veen, J.F. de and Zijlstra, J.J., 1970. Young fish and Brown Shrimp survey in the North Sea. Ann. Biol. 27, 183-187.

Boddeke, R., Daan, N., Posthuma, K.H., Veen, J.F. de and Zijlstra, J.J., 1969. A census of juvenile demersal fish in the Dutch Wadden Sea, the Zeeland nursery ground, the Dutch coastal area and the open sea areas off the coasts of The Netherlands, Germany and the southern part of Denmark. Ann. biol. Copenhagen 26, 269-275.

Boer, W.F. de, Welleman, H.C. and Dekker, W., 2001. De relatie tussen het voorkomen van vissoorten en garnaal in de Demersal Fish Survey in relatie tot het zoutgehalte en andere habitatvariabelen in de Waddenzee Oosterschelde en Westerschelde. Netherlands Insitute for Fisheries Research, pp. 54.

Boere, G. and Stroud, D., 2007. The flyway concept: what it is and what it isn't. In: Waterbirds around the world. Edited by Boere. G.C., Galbraith, C.A. and Stroud, D.A., TSO Scotland Ltd., Edinburgh, UK. pp. 940.

Bolle, L.J., Dapper, R., Witte, J.Y. and Veer, H.W. van der, 1994. Nursery grounds of dab (Limanda limanda L.) in the southern North Sea. Neth. J. Sea Res. 32, 299-307.

Bommelé, M., 1991. Harmful effects on birds of floating lipophilic substances discharged from ships. In: Camphuysen, C.J., and Franeker, J.A. van, (Eds.). Oil pollution, Beached Bird Surveys and Policy: towards a more effective approach to an old problem. Proc. Int. NZG/NSO workshop, 19 April 1991, Rijswijk, Sula 5 (special issue), 44-45.

Bos, D., R. H. Drent, B. S. Ebbinge, J. Frikke, D. J. de Jong, K. Koffijberg, J. Madsen, P. Potel, K. Günther, M. Stock, P. Südbeck, 2005. Capacity of Wadden Sea coastal grasslands for Dark-bellied Brent Goose. Journal of Wildlife Management.

Boschert, M., 2005. Vorkommen und Bestandsentwicklung seltener Brutvogelarten in Deutschland 1997 bis 2003. Die Vogelwelt 126, 1-51.

Breckling, P. and Neudecker, T., 1994. Monitoring the fish fauna in the Wadden Sea with stow nets (Part 1): A comparison of demersal and pelagic fish fauna in a deep tidal channel. Arch. Fish. Mar. Res. 42 (1), 3-15.

Brink, P. van den and Kater, B.J., 2000. Bioassays and chemical contents: is there a relation? Multivariate analysis of chemical and biological assessment in sediments of the Wadden Sea and sea harbour channel. (In Dutch). Report Alterra 186, ISSN 1566-7197. November 2000.

Brinkman, A.G., Ens, B.J., Kersting, K., Baptist, M., Vonk, M., Drent, J., Janssen-Stelder, B.M. and Tol, M.W.M. van der, 2001. Modelling the impact of climate change on the Wadden Sea ecosystems. Dutch national research programme on global air pollution and climate change, Report no. 410 200 066.

Brinkman, A.G. and Bult, T., 2002. Geschikte eulitorale gebieden in de Nederlandse Waddenzee voor het voorkomen van meerjarige natuurlijke mosselbanken. Hoofdrapport voor deelproject F2 van EVA II. Alterra rapport 456.

Brinkman, A.G. and Smaal, A.C., 2003. Onttrekking en natuurlijke productie van schelpdieren in de Nederlandse Waddenzee in de periode 1976-1999. Alterra rapport 888, 1-221, Alterra, Wageningen.

Brinkman, A.G., Bult, T., Dankers, N., Meijboom, A., den Os, D., van Stralen, M.R. and de Vlas, J., 2003. Mosselbanken, kenmerken, oppervlaktebepaling en beoordeling van stabiliteit. Alterra-rapport 707, ISSN 1566-7197.

Brinkman, A.G., Ens, B.J. and Kats, R.K.H., 2003. Modelling the energy budget and prey choice of eider ducks. Alterra rapport 839, 133 pp., Alterra, Wageningen.

Brockmann, U.H., Topcu, D. and Schütt, M., 2004. Bewertung der Eutrophierungsituation (Nährstoffe und Phytoplankton) zur Umsetzung der WRRL in den Übergangs- und Küstengewässern an der Westküste Schleswig-Holsteins (Final Report for LANU), October 2004, pp. 70.

Brongers, M. and Berg, G., 1996. Vegetatiekartering van de duinen van Vlieland. Bureau Altenburg and Wymenga.

Brussaard, C.P.D, Thyrhaug, R., Marie, D. and Bratbak, G., 1999. Flow cytometric analyses of viral infection in two marine phytoplankton species, Micromonas pusilla (Prasinophyceae and Phaeocystis pouchetii (Prymnesiophyceae). J. Phycol. 35: 941-948.

BRWE, 1997. Generalplan Küstenschutz für den Regierungsbezirk Weser-Ems (BRWE), Oldenburg.

Buehler, D.M., Baker, A.J. and Piersma, T., 2006. Reconstructing palaeoflyways of the late Pleistocene and early Holocene Red Knot (Calidris canutus). Ardea 94.

Buhs, F. and Reise K., 1997. Epibenthic fauna dredged from tidal channels in the Wadden Sea of Schleswig-Holstein: spatial patterns and a long-term decline. Helgol. Meeresunters. 51, 343-359.

Buijsman, E., 2003. Kansen voor natuurherstel in relatie tot milieukwaliteit. Syllabus from the Staatbosbeheer dune symposium in May 2003 on Terschelling.

Bult, T.P., Stralen, M.R. van, Brummelhuis, E and Baars, J.M.D.D., 2004. Mosselvisserij en -kweek in het sublitoraal van de Waddenzee. RIVO rapport C049/04, 1-86.

Bunje, J. and Ringot, J.L., 2003. Lebensräume im Wandel. Flächenbilanz von Salzwiesen und Dünen im niedersächsischen Wattenmeer zwischen den Jahren 1966 und 1997. Eine Luftbildauswertung. Schriftenreihe Nationalpark Niedersächsisches Wattenmeer, Band 7, Nationalparkverwaltung Wilhelmshaven, pp. 48.

Buschbaum, C., 2000. Direct and indirect effects of *Littorina littorea* (L.) on barnacles growing on mussel beds in the Wadden Sea. Hydrobiologia 440, 119-128.

Buschbaum, C. and Saier, B., 2001. Growth of the mussel *Mytilus edulis* L. in the Wadden Sea affected by tidal emergence and barnacle epibionts. J. Sea Res. 45: 27-36.

Buschbaum, C., 2002a. Siedlungsmuster und Wechselbeziehungen von Seepocken (Cirripedia) auf Muschelbänken (*Mytilus edulis* L.) im Wattenmeer. Ber. Polarforsch. Meeresforsch. 408, 1-143.

Buschbaum, C., 2002b. Predation on barnacles of intertidal and subtidal mussel beds in the Wadden Sea. Helgol. Mar. Res. 56, 37-43.

Buschbaum, C., and Saier, B., 2003. Ballungszentrum Muschelbank – Biodiversität und nachhaltige Nutzung. Biol. Unserer Zeit 33(2), 100-106.

Buschbaum, C., 2004. Pest oder Bereicherung? Der eingeschleppte Japanische Beerentang Sargassum muticum an der deutschen Nordseeküste. Natur und Museum.

Cadée, G.C. and Hegeman, J., 2002. Phytoplankton in the Marsdiep at the end of the 20th century; 30 years monitoring biomass, primary production and Phaeocystis blooms. J. Sea Res. 48, 97-110.

Cadée, G. C. 2007. Vervangen de recente Japanse oesterriffen de vroegere oesterbanken? De Levende Natuur 108: 64-67.

Camphuysen, C.J., 1989. Beached Bird Surveys in the Netherlands 1915-1988; Seabird Mortality in the southern North Sea since the early days of Oil Pollution. Techn. Rapport Vogelbescherming 1, Werkgroep Noordzee, Amsterdam pp. 322.

Camphuysen, C.J. and Franeker, J.A. van, 1992. The value of beached bird surveys in monitoring marine oil pollution. Technisch Rapport Vogelbescherming 10, Vogelbescherming Nederland, Zeist, pp. 191.

Camphuysen, C.J. and Leopold, M.F., 1994. Atlas of seabirds in the Southern North Sea. IBN Research Report 94/6. NIOZ-Report 1994-8, Institute for Forestry and Nature Research, Dutch Seabird Group and Netherlands Institute for Sea Research, Texel, pp. 12.

Camphuysen, C.J., 1994. The Harbour Porpoise *Phocoena phocoena* in the southern North Sea, II: a come-back in Dutch coastal waters? Lutra 37, 54-61.

Camphuysen, C.J., and Dahlmann, G., 1995. Guidelines on standard methodology for the use of (oiled) beached birds as indicators of marine pollution. Ad Hoc working group on Monitoring, Oslo and Paris Convention for the Prevention of Marine Pollution. MON 95/7, Agenda item 7, 13-17 November 1995, Copenhagen.

Camphuysen, C.J., and Meer, J. van der, 1996. Recent trends in oiled seabirds. Ad Hoc working group on Monitoring, Oslo and Paris Convention for the Prevention of Marine Pollution, Environmental Assessment and Monitoring Committee (ASMO) . MON 1995 summary record, Copenhagen, 20-48.

Camphuysen, C.J., B.J. Ens, D. Heg, J.B. Hulscher, J. van der Meer, C.J. Smit, 1996. Oystercatcher Haematopus ostralegus winter mortality in The Netherlands: the effect of severe weather and food supply. Ardea, 84A, 469-492.

Camphuysen, C.J., 1997. Olievervuiling en olieslachtoffers langs de Nederlandse kust, 1969-97: signalen van een schonere zee. Sula 11(2) special issue, 41-156.

Camphuysen, C.J., 1998. Beached bird surveys indicate decline in chronic oil pollution in the North Sea. Mar. Poll. Bull. 36, 519-526.

Camphuysen, C.J., Barreveld, H., Dahlmann, G. and Franeker, J.A. van, 1999. Seabirds in the North Sea demobilised and killed by polyisobutylene (C4H8)n. Marine Pollution Bulletin 38(12), 1171-1176.

Camphuysen, C.J. and Garthe, S., 2000. Seabirds and commercial fisheries: population trends of piscivorous seabirds explained? In: Kaiser M.J. and Groot S.J. de, (Eds.). Effects of fishing on non-target species and habitats: Biological, Conservation and Socio-Economic Issues, Blackwell Science, Oxford, 163-184.

Camphuysen, C.J. and Heubeck, M., 2001. Marine oil pollution and beached bird surveys: the development of a sensitive monitoring instrument. Environmental Pollution 112, 443-461.

Camphuysen, C.J., 2001. Eider mortality in the Dutch Wadden Sea, Winter 1999/2000. Wadden Sea Newsletter 2001, no.1, 4-5.

Camphuysen, C.J., C. M. Berrevoets, H. J. W. M. Cremers, A. Dekinga, R. Dekker, B. J. Ens, T. M. van der Have, R. K. H. Kats, T. Kiuken, M. F. Leopold, J. van der Meer, T. Piersma, 2002. Mass mortality of Common Eiders (*Somateria mollissima*) in the Dutch Wadden Sea, winter 1999/2000: starvation in a commercially exploited wetland of international importance. Biol. Cons. 106, 303-317.

Camphuysen, C.J., 2003. North Sea pilot project on Ecological Quality Objectives, Issue 4. Seabirds, EcoQO element F. Proportion of oiled Common Guillemots among those found dead or dying. CSR Report 2004-011, Texel, pp. 26.

Camphuysen, C.J., 2005. The return of the harbour porpoise (Phocoena phocoena) in Dutch coastal waters. Lutra 48 (2005).

Carter, R.W.G., 1989. Coastal environments. Academic Press, London, pp. 617.

Clark, J.A. 2004. Ringing recoveries confirm higher wader mortality in severe winters. Ringing and Migration 22, 43-50.

Clausen, P., Bøgebjerg, E., Hounisen, J.P., Jørgensen, H.E. and Petersen, I.K., 2004. Reservatnetværk for trækkende vandfugle. En gennemgang af udvalgte arters antal og fordeling i Danmark 1994-2001. Danmarks Miljøundersøgelser. - Faglig rapport fra DMU 490. pp.144.

Clausen, P., Kahlert, J., Hounisen, J.P. and Petersen, I.K., 2005. Tøndermarskens ynglefugle 2004. Naturovervågning. Danmarks Miljøundersøgelser. - Arbejdsrapport fra DMU 209. DMU, Kalø.

COFAD, 2004. Die Küstenfischerei in Niedersachsen. Stand und Perspektiven. Cofad GmbH, Tutzing, pp. 170.

Colijn, F., Dankers, N. & Jensen, A., 1995. The need for reference areas for scientific research and (nature) management. Wadden Sea Newsletter 1995-2: 17-19.

COMRISK, 2002. Common Strategies to Reduce the Risk of Storm Floods in Coastal Lowlands.

CONTIS Information System, Bundesamt für Seeschifffahrt und Hydrographie.. Nordsee Offshore-Windparks

Cowi, 2004. Report and assessment of socio-economic data in the Danish sector of the Wadden Sea Region. Wadden Sea Forum Report No. 2, 36 pp.

Coyer, J.A., Diekmann, O.E., Serrão, E.A., Procaccini, G., Milchakova, N., Pearson, G.A., Stam, W.T. and Olsen, J.L., 2004. Population genetics of dwarf eelgrass *Zostera noltii* throughout its biogeographic range. Mar. Ecol. Prog. Ser. 281:51-62.

CPSL, 2001. Coastal protection and sea level rise. Final report of the trilateral working group on coastal protection and sea level rise (CPSL). Wadden Sea Ecosystem No. 13, Common Wadden Sea Secretariat, Wilhelmshaven, Germany.

CPSL, 2005. Coastal Protection and Sea Level Rise – Solutions for sustainable coastal protection in the Wadden Sea region. Wadden Sea Ecosystem 21. Common Wadden Sea Secretariat Wilhelmshaven.

Craeymeersch, J.A., Leopold, M.F. and Wijk, van M.O., 2001. Halfgeknotte strandschelp en Amerikaanse zwaardschede: een overzicht van bestande kennis over visserij, economische betekenis, regelgeving, ecologie van de bevist soorten en effecten op het ecosystem. RIVO Rapport no. C033/01.

Crick, H.Q.P. 2004. The impact of climate change on birds. Ibis 146 (suppl. 1), 48-56.

Crooks, S. 2004. The effect of sea-level rise on coastal geomorphology. Ibis 146 (suppl. 1), 18-20.

CSO, 2001. Morfologisch onderzoek Bocht van Watum, 1990-2000. Rapport 1J077.00-1. Commissioned by National Institute for Coastal and Marine Management/RIKZ, Den Haag.

Cushing, D.H. and Dickson, R.R., 1976. The biological response in the sea to climate changes. Adv. Mar. Biol. 14, 1-122.

CWSS, 2002. Status reports on the Elbe Flood 2002. Common Wadden Sea Secretariat, Wilhelmshaven.

CWSS, 2002a. Shellfish Fisheries. An overview of policies for shellfish fishing in the Wadden Sea. Common Wadden Sea Secretariat, Wilhelmshaven, Germany, pp. 21.

CWSS, 2002b. Blue Mussel Monitoring. Report of the Second TMAP Blue Mussel Workshop on Ameland, 8-10 April 2002. Common Wadden Sea Secretariat, Wilhelmshaven, Germany.

Dahlmann, G. and A. Sechehaye, 2000. Verölte Seevögel an der deutschen Nordseeküste 1998/99 – Ergebnisse der Ölanalysen. - Seevögel 21/1, 11 - 12.

Dahlmann, G., 1991. Oil identification for court evidence. In: Camphuysen, C.J. and Franeker, J.A. van, (Eds.). Oil pollution, Beached Bird Surveys and Policy: towards a more effective approach to an old problem. Proc. Int. NZG/NSO workshop, 19 April 1991, Rijswijk, Sula 5 (special issue), 29-32.

Dahlmann, G., Timm, D., Averbeck, C., Camphuysen, C.J. and Skov, H., 1994. Oiled seabirds - Comparative investigations on oiled seabirds and oiled beaches in the Netherlands, Denmark and Germany (1990-1993). Mar. Poll. Bull. 28, 305-310.

Dalfsen, J.A. and K. Essink, 1997. Risk analysis of coastal nourishment techniques. RIKZ Report 97.022. RIKZ, Haren.

Damm, U. & T. Neudecker 2006. Zweikampf im Wattenmeer – Wird die heimische Miesmuschel verdrängt? Inf. Fischereiforsch. 53:46-48.

Dankers, N.M.J.A, Meijboom, A., Cremer, J.S.M., Dijkman, E.M., Heremes, Y., Te Marvelde, L., 2003. Historische ontwikkeling van droogvallende mosselbanken in de Nederlandse Waddenzee. Alterra rapport 876, Alterrra, Wageningen, pp. 114.

Dankers, N, E Dijkman, M de Jong, G de Koort & A Meijboom 2004: De verspreiding en uitbreiding van de Japanse Oester in de Nederlands Waddenzee. Alterra-rapport 909, Texel.

Dankers, N.M.J.A., Dijkman, E.M., Jong, M.L. de, Kort, G. de, and Meijboom, A., 2004. De verspreiding en uitbreiding van de Japanse Oester in de Nederlandse Waddenzee. Wageningen, Alterra, Alterra-rapport 909, pp. 51.

Dankers, N.M.J.A., Herlyn, M., Kristensen, P.S., Michaelis, H., Millat, G., Nehls, H. and Ruth, M., 1999. Blue mussels and blue mussel beds in the littoral. In: Jong, F. de, Bakker, J.F., van Berkel, C.J.M., Dankers, N.M.J.A., Dahl, K., Gätje, C., Marencic, H. and Potel, P. (Eds.), 1999. 1999 Wadden Sea Quality Status Report. Wadden Sea Ecosystem No. 9. Common Wadden Sea Secretariat, Trilateral Monitoring and Assessment Group, Quality Status Report Group. Wilhelmshaven, 141-145.

Dankers, N., A. Meijboom, M. de Jong, E. Dijkman, J. Cremer, F. Fey, A. Smaal, J, Craermeersch, E. Brummelhuis, J. Steenbergen & D. Baars 2006. De ontwikkeling van de Japanse oester in Nederland (Waddenzee en Oosterschelde). Wageningen IMARES Rapport nr. C040/06

Davidson, N., 2003. Declines in East Atlantic wader populations: Is the Wadden Sea the problem? Wader Study Group Bulletin, 101/102, 19.

Deceuninck, B., R. Maheo, 2000. Synthesis of counts and trend analyses of wintering waders in France 1978-1999. Ligue pour la Protection des Oiseaux (LPO) (BirdLife France), Wetlands International, Wageningen, NL, pp. 82.

Dekker, R. and Waasdorp, D., 2004. Het Macrobenthos in de Waddenzee in 2003. NIOZ report 2004-3, pp. 55.

Delafontaine, M.T., Flemming, B.W. and Mai, S., 2000. The Wadden Sea squeeze as a cause of decreasing sedimentary organic loading. In: Flemming, B.W., Delafontaine, M.T. and Liebezeit, G. (Eds.). Muddy coast dynamics and resource management. Elsevier Science, pp. 273-286.

Delany, S. and D. Scott, 2002. Waterbird population estimates. Third edition. Wetlands Int. Global Ser. Nr. 12, Wetlands International, Wageningen.

Dellwig, O., Hinrichs, J., Hild, A. and Brumsack, H.-J., 2000. Changing sedimentation in tidal flat sediments of the southern North Sea from the Holocene to the present: a geochemical approach. J. Sea Res. 44:195-208.

Deppe, L., 2003. Die Trauerente (*Melanitta nigra*) in der Deutschen Bucht - GIS-basierte Bewertung räumlicher und zeitlicher Parameter. Dipl-Arbeit, Universität Hamburg.

Desholm, M., T. K. Christensen, G. Scheiffarth, M. Hario, Å. Andersson, B. J. Ens, C. J. Camphuysen, L. Nilsson, C. M. Waltho, S.-H. Lorentsen, A. Kuresoo, R. K. H. Kats, D. M. Fleet, A. D. Fox, 2002. Status of the Baltic/Wadden Sea population of the Common Eider *Somateria m. mollissima*. Wildfowl 53, 167-203.

Deutch, B., Pedersen, H.S., Bonafeld-Jørgensen, E. and Hansen, J., 2002. The AMAP human health program for Greenland 1999-2001: organic pollutants, lifestyle, dietary composition and blood lipids. Poster at the Second AMAP International Symposium on Environmental Pollution of the Arctic, Rovaniemi, 1-4 October 2002.

Dickson, B., Yashayaev, I., Meincke, J., Turrell, B., Dye, S. and Holfort, J., 2002. Rapid freshening of the deep North Atlantic ocean over the past four decades. Nature 416: 832 – 837.

Diederich, S., Nehls, G., van Beusekom, J. E. E., Reise, K., 2004. Introduced Pacific oysters (*Crassostrea gigas*) in the northern Wadden Sea: Invasion accelerated by warm summers? Helgol. Mar. Res.

Diederich S. 2005. Invasion of Pacific oysters (*Crassostrea gigas*) in the Wadden Sea: competitive advantage over native mussels. PhD thesis, University of Kiel.

Diederich, S., Nehls, G., Beusekom, J. E. E. van, Reise, K. 2005. Introduced Pacific oysters (*Crassostrea gigas*) in the northern Wadden Sea: Invasion accelerated by warm summers?, Helgol Mar Res 59: 97-106, doi:10.1007/s10152-004-0195-1.

Diederich, S. 2006. High survival and growth rates of introduced Pacific oysters may cause restrictions on habitat use by native mussels in the Wadden Sea. J Exp mar Biol 328: 211-227, doi:10.1016/j.jembe.2005.07.012.

Diederichs, A. and Grajetzky, B. 2004. Boats at sea. Beschreibung des Schiffsverkehrs im Nationalpark Schleswig-Holsteinisches Wattenmeer als Parameter 'Boats at sea' im Rahmen des Trilateral Monitoring and Asessment Program TMAP – im Auftrag des Nationalparkamtes, 40 pp.

Dieren, J.W. van, 1934. Organogene Dünenbildung, eine geomorphologische Analyse der westfriesischen Insel Terschelling mit pflanzensoziologischen Methoden. Ph.D. thesis, University of Amsterdam.

Dijk, H.W.J. van and Grootjans, A.P., 1993. Wet dune slacks: decline and new opportunities. Hydrobiologia 265: 281-304.

Dijkema, K.J., 1987. Geography of salt marshes in Europe. Z. Geomorph. N.F. 31: 489-499.

Dijkema, K.S. (Ed.), Beeftink, W.G., Doody, J.P., Gehu, J.M. Heydemann, B. and Rivas Martinez, S., 1984. Salt marshes in Europe. Council of Europe. Nature and Environment Series 30, Strasbourg, pp. 178.

Dijkema, K.S., 1987. Changes in salt-marsh area in the Netherlands Wadden Sea after 1600. In: Huiskes, A.H.L., Blom, C.W.P.M. and Rozema, J. (Eds.). Vegetation between land and sea. W. Junk. Publ., Dordrecht, pp. 42-49.

Dijkema, K.S., 1989. Habitats of The Netherlands, German and Danish Wadden Sea. 24 maps 1: 100,000 and legend. Research Institute for Nature Management, Texel and Veth foundation, Leiden.

Dijkema, K.S., 1997. Impact prognosis for salt marshes from subsidence by gas extraction in the Wadden Sea. Journal of Coastal Research 13 (4), 1294-1304.

Dijkema, K.S., Nicolai, A., de Vlas, J., Smit, C.J., Jongerius, H. and Nauta, H., 2001. Van landaanwinning naar kwelderwerken. Leeuwarden, Rijkswaterstaat Noord-Nederland en Texel, Alterra, Research Instituut voor de Groene Ruimte, pp. 68.

Dijkema, K.S. et al., 2003. Jaarverslag 2003 Monitoring en beheer van de kwelderwerken in Friesland en Groningen (November 2003 – November 2003). Werkgroep Onderzoek Kwelderwerken. Alterra, Texel en Rijkswaterstaat Leeuwarden en Delfzijl.

Dijksen, L. and Koks, B., 2003. Broedvogelmonitoring in het Nederlandse Waddengebied in 2002. Sovon-monitoringrapport 2003/03. SOVON, Beek-Ubbergen.

Dillingh, D. and Heinen, P.F., 1994. Zeespiegelstijging, getijverandering en deltaveiligheid. Rijksinstituut voor Kust en Zee/RIKZ, Den Haag. Rapport RIKZ-94.026.

Dittmann, S., 1990. Mussel beds – amensalism or amelioration for intertidal fauna ? Helgol. Meeresunters. 44, 335-352

Dolmer, P., 2002. Mussel Dredging: Impact on Epifauna in Limfjorden, Denmark. Journal of Shellfish Research, 21, 529-537.

Drachenfels, O. von, 2004. Kartierschlüssel für Biotoptypen in Niedersachsen. Niedersächsisches Landesamt für Ökologie. Naturschutz, Hannover.

Drent, J., Luttikhuizen, P.C. and Piersma, T., 2004. Morphological dynamics in the foraging apparatus of a deposit feeding marine bivalve: phenotypic plasticity and heritable effects. Functional Ecology 18, 349-356.

Drent, R. H., Fox, A.D. and Stahl J., 2005. Travelling to breed. J. Ornithol 147, 122-134.

Drent, R., Bakker, J.P., Piersma, T. & Tinbergen, J.M. (Eds.) 2005. Seeking nature's limits: Ecologists in the field, KNNV Publishing, Utrecht: pp. 312.

Duin, W.E. van, Dijkema, K.S., Bunje, J., Pedersen, T.F. and Stock, M., 1999. Salt marshes. In: Jong, F. de, Bakker, J.F., van Berkel, C.J.M., Dankers, N.M.J.A., Dahl, K., Marencic, H. and Potel, P. (Eds.). Wadden Sea Quality Status Report. Wadden Sea Ecosystem No. 9, Common Wadden Sea Secretariat, Trilateral Monitoring and Assessment Group, Quality Status Report Group. Wilhelmshaven, Germany, 165-170.

Duncker, G. and Ladiges, W., 1960. Die Fische der Nordmark. Kommisionsverlag Cram, de Gruyter u. Co., Hamburg, pp. 432.

Durinck, J. and Skov. H., 2001. Trends in marine oil pollution in Denmark 1984-2001. Report to the Danish Environmental Protection Agency, Danish Ministry of Environment. Ornis Consult Report.

Duyzer, J.H. and Vonk, A.W., 2002. Atmospheric deposition of pesticides, PAHs and PCBs in The Netherlands. TNO report R2002/606 (in Dutch).

Ebbinge, B. S., C. Berrevoets, P. Clausen, B. Ganter, K. Günther, K. Koffijberg, R. Maheo, M. Rowcliffe, A. K. M. St. Joseph, P. Südbeck, Jr. E. E. Syroechkovsky, 1999. Dark-bellied Brent Goose *Branta bernicla bernicla*. in: Madsen, J., Cracknell, G. & Fox, A. D. (Eds.). Goose populations of the Western Palaearctic. A review of status and distribution. Wetlands International, NL, National Environment Research Institute, DK.

Ebbinge, B. S., R. Schrijver, R. Kwak, B. Schuurman, G. Müskens, 2003. Ganzen opvangbeleid: internationale natuurbescherming in de landbouwpraktijk. Alterra-Report 792. Alterra, Wageningen, NL.

Ebbinge, B.S., 2004. Onderzoek naar het broedsucces van Zwartbuikrotganzen. Limosa 77, 71-78.

Ehrenbaum, E., 1936. Naturgeschichte und wirtschaftliche Bedeutung der Seefische Nordeuropas. Schweitzerbart, Stuttgart.

Elliott, M.F. and Dewailly, F., 1995. The structure and components of European estuarine fish assemblages. Neth. J. Aquat. Ecol. 29, 397-417.

Elliott, M. and Hemingway, K.L., 2002. Fishes in estuaries, London: Blackwell science, pp. 636.

ELSAM, 2005. Environmental Reports 2002 – 2004. http://www.hornsrev.dk

Eltink, W.D., 2004. Organotin and seals in the Dutch Wadden Sea. Report RIKZ/AB/2004.611w, National Institute for Coastal and Marine Management / RIKZ, Haren, Gn (NL).

Enemark J.A., 1993. The protection of the Wadden Sea in an international perspective. Planning, protection and management of the Wadden Sea. In: Hillen R, Verhagen HJ (eds). Coastlines of the Southern North Sea. pp. 202–213

Enemark, J.A.; De Jong, F., 1994. Nationale und internationale Schutzmaßnahmen für das Wattenmeer. In: Lozan, J.L.; Rachor, E.; Reise, K.; Von Westernhagen, H.; Lenz, W. (Hrsg.): Warnsignale aus dem Wattenmeer. Blackwell, Berlin. S. 326-330.

Enemark, J.A., 2005. The Wadden Sea protection and management scheme. Towards an integrated coastal management approach? Ocean & Coastal Management 48: 996–1015.

Ens, B.J., Piersma, T., Zwarts, L. and van de Kam, J., 1999. Ecologische Atlas van de Nederlandse Wadvogels. Schuyt and Co., Haarlem, pp. 368.

Ens, B.J. and Kats, R.K.H., 2003. Evaluatie van voedselreservering van Eidereenden in de Waddenzee. Rapportage in het kader van EVA II deelproject B2. Alterra rapport, 1-152. Alterra, Wageningen.

Ens B.J., R.K.H. Kats, 2004. Evaluatie van Voedselreservering Eidereenden in de Waddenzee- rapportage in het kader van EVA II deelproject B2. Alterra, Wageningen, Alterra rapport 931, 1-155.

Ens, B., Smaal, A.C. and de Vlas, J., 2004. The effects of shellfish fishery on the ecosystems of the Dutch Wadden Sea and Oosterschelde. Final report of the second phase of the scientific evaluation of the Dutch selfish fishery policy (EVAII). Alterrra-rapport 1011; RIVO-rapport C056/04; RIKZ-rapport RKZ/2004.031. Alterra, Wageningen 2004, pp. 212.

Esbjerg Declaration, 2001. Ministerial Declaration of the Ninth Trilateral Governmental Conference on the Protection of the Wadden Sea. Esbjerg, October 2001. Common Wadden Sea Secretariat, Wilhelmshaven.

Eskildsen, K., Fiedler U. and Hälterlein, B., 2000. Die Entwicklung der Brutvogelbestände auf der Hamburger Hallig. In: Stock, M. and Kiehl, K. (Eds.), Die Salzwiesen der Hamburger Hallig. Schriftenreihe des Nationalparks Schleswig-Holsteinisches Wattenmeer 11, 61-65.

Esselink, P., 2000. Nature management of coastal salt marshes. Interactions between anthropogenic influences and natural dynamics. Ph.D. thesis University of Groningen, 256 p.

Esselink, H., Nijssen, M., Duinen, G.J. van, Jansen, J., Geertsma, M., Kuper, J. and Bravenboer, A., 2001. Verkennende studie naar gevolgen van vermesting, verzuring en verdroging én effectgerichte maatregelen op fauna, vegetatie en abiotiek in duinen op Ameland en Terschelling. De 'voorlopige' teloorgang van de Grauwe Klauwier als graadmeter voor insektenrijkdom in de duinen? Report Stichting Bargerveen, Nijmegen.

Esselink, P., De Leeuw, C., Graveland, J., and Berg, G.J., 2003. Ecologische herstelmaatregelen in zoute wateren. Een ecologische evaluatie over de periode 1990 – 2000. rapport RIKZ/2003.028, Rijksinstituut voor Kust en Zee, Middelburg.

Essink, K., 1985. On the occurrence of the American jack-knife clam *Ensis directus* (Conrad, 1843) (Bivalvia, Cultellidae) in the Dutch Wadden Sea. Basteria 49, 73-80.

Essink, K., Beukema, J.J., Madsen, P.B., Michaelis, H., Vedel, G., 1998. Long-term development of biomass of intertidal macrozoobenthos in different parts of the Wadden Sea. Governed by nutrient loads? Senckenbergiana marit. 29: 25-35.

Essink, K., Eppinga, J. and Dekker, R., 1998. Long-term changes (1977-1994) in intertidal macrozoobenthos of the Dollard (Ems Estuary) and effects of introduction of the North American spionid polychaete *Marenzelleria* cf. *wireni*. Senckenbergiana marit. 28: 21-25.

Essink, K., 1999. Dispersal and development of *Marenzelleria* spp. (Polychaeta, Spionidae) populations in NW Europe and The Netherlands. Helgoländer Meeresunters. 52, 367-372.

Essink, K. and Dekker, R., 2002. General patterns in invasion ecology tested in the Dutch Wadden Sea: The case of a brackish-marine polychaetous worm. Biological Invasions 4, 359-368.

Essink, K., de Vlas, J., Nijssen, R. and Poot, G.J.M., 2003. Evaluatieonderzoek Schelpdiervisserij 2e fase (EVA II), Deelonderzoek E: Heeft mechanische kokkelvisserij invloed gehad op de ontwikkeling van zeegras in de Nederlands Waddenzee? Rijksinstituut voor Kust en Zee/RIKZ, Den Haag/Haren, Rapport RIKZ/2003.026.

Essink, K., Dettmann, C., Farke, H., Laursen, K., Leinfelder, R., Lüerßen, G., Marencic, H. and Wiersinga, W. (Eds.) 2005: Wadden Sea Quality Status Report 2004. Wadden Sea Ecosystems No. 19, Common Wadden Sea Secretariat, Wilhelmshaven, Trilateral Monitoring and Assessment Group, Wilhelmshaven, Germany.

Everts, F.H., and de Vries, N.P.J., 1998a. Vegetatiekartering Texel-Noord, Bureau Everts and De Vries, Groningen, 1998.

Everts, F.H. and de Vries, N.P.J., 1998b. Vegetatiekartering Duinen-Zuid Texel 1997. Bureau Everts and De Vries, Groningen, Rapportnummer EV-98/7.

Everts, F.H., and de Vries, N.P.J., 2000. Vegetatiekartering Duinen-midden, Texel. Bureau Everts and De Vries, Groningen, Rapportnummer EV-00/9.

Exo, K.-M., Hüppop, O. and Garthe, S., 2003. Birds and offshore wind farms: a hot topic in marine ecology. Wader Study Group Bull. 100, 50–53.

Eysink, W.D., Dijkema, K.S., van Dobben, H.F., Slim, P.A., Smit, C.J., de Vlas, J., Sanders, M.E., Wiertz, J. and Schouwenberg, E.P.A.G., 2000. Monitoring effecten bodemdaling op Ameland-Oost. Evaluatie na 13 jaar gaswinning. Begeleidingscommissie Monitoring Bodemdaling Ameland.

Fey, F., N. Dankers, A. Meijboom, M. de Jong, P.-W. van Leeuwen, E. Dijkman & J. Cremer 2007. De ontwikkleing van der Japanse oester in de Nederlandse Waddenzee: Situatie 2006. Wageningen IMARES Interne Rapportage Nummer: 07.003.

Fleet, D.M., Frikke J., Südbeck P. and Vogel, R.L., 1994. Breeding birds in the Wadden Sea 1991. Wadden Sea Ecosystem No. 1. Common Wadden Sea Secretariat, Wilhelmshaven.

Fleet, D. M. and Reineking, B., 2000. Have efforts to clean up the marine environment been successful? - German beached bird surveys provide an index for oil pollution levels in the southern North Sea. In: Rodrigues, G.R. and C.A. Trebbia, (Eds.). Oil & Hydrocarbon Spills II, Modelling, Analysis and Control. WITPress, 117-126.

Fleet, D. M. and Reineking, B., 2001. Bestimmung, Quantifizierung und Bewertung der Öleinträge in der Nordsee zur Beurteilung der Schiffsentsorgung in deutschen Nordseehäfen. UBA-Berlin, FKZ 297 25 310, Hochschule Bremen, pp. 279.

Fleet, D. M., S. Gaus & M. Schulze Dieckhoff, 2003. Zeigt die Ausweisung der Nordsee als MARPOL-Sondergebiet für Öl die ersten Erfolge? Ölopfer in der Deutschen Bucht in den Wintern 2000/2001 und 2001/2002. Seevögel Band 24/1, 16-23.

Flemming, B.W. and Davis, R.A., 1994. Holocene evolution, morphodynamics and sedimentology of the Spiekeroog barrier island system (southern North Sea). Senckenberg maritima 24: 117-155.

Flemming, B.W. and Nyandwi, N., 1994. Land reclamation as a cause of fine-grained sediment depletion in backbarrier tidal flats, southern North Sea. Neth J Aquat Ecol 28: 299-307.

Flemming, B.W., 2002. Effects of climate and human interventions on the evolution of the Wadden Sea depositional system (southern North Sea). In: Wefer, G., Berger, W., Behre, K.E., Jansen, E. (Eds.). Climate development and history of the North Atlantic realm. Springer-Verlag, Heidelberg, 399-413.

Fletcher, R.L., 1996. The occurrence of “green tides” – a review. In: Schramm/Nienhuis (eds) Marine benthic vegetation. Ecological Studies, Springer-Verlag 123, 7-43.

Flore, B-O., 1997. Brutbestand, Bruterfolg und Gefährdungen von Seeregenpfeifern (*Charadrius alexandrinus*) und Zwergseeschwalben (*Sterna albifrons*) im Wattenmeer von Niedersachsen. Vogelkdl. Ber. Niedersachs. 29, 85-102.

Fonds, M., 1978. The seasonal distribution of some fish species in the western Dutch Wadden Sea. In: Dankers, N.; Wolff, W. J. and Zijlstra, J.J. (Eds.), 1978. Fishes and fisheries in the Wadden Sea. Report 5 of the final report of the section 'Fishes and fisheries' of the Wadden Sea Working Group. Stichting Veth tot Steun aan Waddenonderzoek, Leiden, 42-77.

Fonds, M., Jaworski, A., Iedema, A. and Puyl, P.v.d., 1989. Metabolism, food consumption, growth and food conversion of the shorthorn sculpin (*Myoxocephalus scorpius*) and eelpout (*Zoarces vivparus*). ICES CM 1989/G:31, pp. 10.

Fonds, M., Cronie, R., Vethaak, A.D. and Puyl, P.v.d., 1992. Metabolism, food consumption and growth of plaice (*Pleuronectes platessa*) and flounder (*Platichthys flesus*) in relation to fish size and temperature. Neth. J. of Sea Res. 29, 127-143.

Frank, D., 2003. Erfassung ausgewählter touristischer Aktivitäten im Niedersächsischen Wattenmeer – Wattwanderer. Bericht für das TMAP im Auftrag der Nationalparkverwaltung Niedersächsisches Wattenmeer. Wilhelmshaven, Berichte 2000, 2001, 2002, 2003. unveröffentlicht.

Frank, D., 2006. Untersuchung des Bruterfolgs von Strandbrütern im Nationalpark Niedersächsisches Wattenmeer im Bereich der Krummhörn. Im Auftrag der Nationalparkverwaltung Niedersächsisches Wattenmeer, Wilhelmshaven.

Frederiks, B, van Hoorn, M.K. and van de Ven, C.L.M., 2004. Survey of problematic compounds in the Dutch Wadden Sea and Ems-Dollard. RIKZ Internal document RIKZ.2004.616w (in Dutch), (Inventaristaie probleemstoffen Waddenzee en Eems-Dollard). Rijkswaterstaat.

Freund, H., Petersen, J. and Pott, R., 2002. Investigations on recent and subfossil salt marsh vegetation of the East Frisian barrier islands in the southern North Sea (Germany). - Phytocoenologia 33 (2-3), 349-375

Freyhof, J. and Schöter, C., 2005. The Houting, *Coregonus oxyrinchu*s (L.), a globally extinct species from the North Sea basin (Salmoniformes: Coregonidae). J. Fish Biol.

Frikke, J., Witt, P., and Ejbye-Ernst, M., 2002. Naturovervågning i Ribe Amt. Strandenge i Ribe Amt. Status 2002. Ribe Amt.

Fromke, A., 1996. Vergleichende geobotanische Untersuchungen der Ostfriesischen Inseln Baltrum und Langeoog im Nationalpark 'Niedersächsisches Wattenmeer'. Ph.D. thesis, Univ. Hannover, pp. 229.

Furness, R.W., and Camphuysen, C.J., 1997. Seabirds as monitors of the marine environment. ICES J. Mar. Sc. 54, 726-737.

Ganter, B. and Rösner, H.U., 2006. Natal philantry and dispersal in Dunlin (*Calidris alpina*). IOC presentation Hamburg, 2006.

Ganter, B., K. Larsson, E. V. Syroechkovsky, K. E. Litvin, A. Leito, J. Madsen, 1999. Barnacle Goose Branta leucopsis. in: Madsen, J., Cracknell, G. & Fox, A.D. (Eds.). Goose populations of the Western Palaearctic. A review on status and distribution. Wetland International, NL, National Environmental Research Institute, DK.

Garthe, S. and Kubetzki, U., 1998. The diet of Sandwich Terns *Sterna sandvicensis* on Juist, southern North Sea. Sula 12: 13-18.

Garthe, S., Camphuysen, C.J. and Furness, R.W., 1996. Amounts of discards by commercial fisheries and their significance as food for seabirds in the North Sea. Mar. Ecol. Prog. Ser. 136, 1-11.

Garthe, S., Flore, B-O., Hälterlein, B., Hüppop, O., Kubetzki U. and Südbeck, P. 2000. Die Brutbestandsentwicklung der Möwen (Laridae) an der deutschen Nordseeküste in der zweiten Hälfte des 20. Jahrhunderts. Vogelwelt 21, 1-13.

Garthe, S., 2003. Verteilungsmuster und Bestände von Seevögeln in der Ausschließlichen Wirtschaftszone (AWZ) der deutschen Nord- und Ostsee und Fachvorschläge für EU-Vogelschutzgebiete. Berichte zum Vogelschutz, 40, 15-56.

Garthe, S., O. Hüppop, 2004. Scaling possible effects of marine wind farms on seabirds: developing and applying a vulnerability index. Journal of Applied Ecology, 41, 724-734.

Gätje, C., 2000a. Der Mensch in der Nationalparkregion. In: Wattenmeermonitoring 1999. Schwerpunktthema: Der Mensch in der Nationalparkregion. Edited by Landesamt für den Nationalpark Schleswig-Holsteinisches Wattenmeer. Schriftenreihe des Nationalparks Schleswig-Holsteinisches Wattenmeer, Tönning, Sonderheft. p. 30-51.

Gätje, C., 2000b. Socio-economic Monitoring in the Wadden Sea of Schleswig-Holstein. Wadden Sea Newsletter 2000-1, 16-17.

Gätje, C., 2003. Socio-economic targets for the Wadden Sea. In: Wolff, W.J., Essink, K., Kellermann, A. and van Leeuwe, M.A. (Eds.). Challenges to the Wadden Sea. Proceedings of the 10th International Scientific Wadden Sea Symposium, Groningen, The Netherlands, 31 October - 3 November 2000. Ministry of Agriculture, Nature Management and Fisheries / Dept. Of Marine Biology, University of Groningen, pp. 221-229.

Gätje, C. 2004. Double strategy towards sustainable tourism: offers for visitors and opportunities for people employed in tourism in the Wadden Sea National Park in Schleswig-

Holstein. In: Sievänen, Tuija, Erkkonen, Joel, Jokimäki, Jukka, Saarinen, Jarkko, Tuulentie, Seija & Virtanen, Eija (eds.). 2004. Policies, methods and tools for visitor management proceedings of the second International Conference on Monitoring and Management of Visitor Flows in Recreational and Protected Areas, June 16-20, 2004, Rovaniemi, Finland. Metlan työraportteja / Working Papers of the Finnish Forest Research Institute 2. 417 p. ISBN 951-40-1930-X.

Gätje, C., 2004b. Sozio-ökonomisches Monitoring der schleswig-holsteinischen Wattenmeerregion. In: Voller Leben – UNESCO-Biosphärenreservate: Modellregionen für eine Nachhaltige Entwicklung. Edited by MAB-Nationalkomitee, Springer, Berlin-Heidelberg. pp. 245-251.

Gätje, C., Laursen, K., Eekhof, H. and Borchardt, T., 2005. Tourism and recreation. In: Essink, K., Dettmann, C., Farke, H., Laursen, K., Lüerßen, G., Marencic H. and Wiersinga W. (Eds.). Wadden Sea Quality Status Report 2004. Wadden Sea Ecosystem No. 19. Common Wadden Sea Secretariat, Trilateral Monitoring and Assessment Group, Wilhelmshaven.

Gercken, J. and Sordyl, H., 2002. Intersex in feral marine and freshwater fish from northeastern Germany. Mar. Environ. Res. 54: 651-655.

Gerlach, A., Albers, E.A. and Broedlin, W., 1994. Development of the nitrogen cycle in the soils of a coastal succession. Acta Bot. Neerl. 43 (3): 189-203.

Gils, J.A. van, Rooij, S.R. de, Belle, J. van, Meer, J. van der, Dekinga, A., Piersma, T. and Drent, R.. 2005a. Digestive bottleneck affects foraging decisions in Red Knots *Calidris canutus*. I. Prey choice. Journal of Animal Ecology 74, 105-119.

Gils, J.A. van, Battley, P.F., Piersma, T. and Drent, R., 2005b. Reinterpretation of gizzard sizes of red knots world-wide, emphasizes overriding importance of prey quality at migratory stopover sites. Proceedings of the Royal Society B 272, 2609-2618.

Gils, J.A. van, Spaans, B., Dekinga, A. and Piersma, T., 2006a. Foraging in a tidally structured environment by Red Knots (Calidris canutus): ideal, but not free. Ecology 87, 1189–1202.

Gils, J.A. van, Piersma, T., Dekinga, A., Spaans, B. and Kraan, C.. 2006b. Shellfish-dredging pushes a flexible avian toppredator out of a protected marine ecosystem. Public Library of Science – Biology 4, e376.

Goor, M.A. van, Stive, M.J.F, Wang, Z.B. and Zitman, T.J., 2001. Influence of relative sea level rise on coastal inlets and tidal basins. Proc. 4th Conf. on Coastal Dynamics, ASCE, Lund, Sweden, pp. 242-252.

Görlitz, S., 2005. Neue Riffe im Wattenmeer: Die Pazifische Auster *Crassostrea gigas* und ihre assoziierte Lebensgemeinschaft. Diplomarbeit, University of Kiel.

Goudswaard, P. C., J. Steenbergen, J. M. D. D. Baars, J. J. Kesteloo, J. Jol & M. R. van Stralen 2006. Het mosselbestand en het areaal aan mosselbanken op de droogvallende platen in de Waddenzee in het voorjaar van 2006. Wageningen Rapport nr. C059/06.

Goudswaard, P. C, J. J. Kesteloo & M. R. van Stralen 2007. Het bestand aan Japanse Oesters in het litoraal van Nederlands deel van de Waddenzee in 2004 – 2006. Unpubl. Report, IMARES.

Green, E.P. and Short, F.T., 2003. World Atlas of Seagrasses. University of California Press, Berkeley.

Grenfell, B.T., M.E. Lonergan and J. Harwood 1992. Quantitative investigations of the epidemiology of phocine distemper virus PDV in European common seal populations. Sci. tot. Environm. 115: 15-29.

Groot, S.J. de, 1989. Decline of the catches of coregonids and migratory smelt in the lower Rhine, the Netherlands. ICES C.M. 1989/M:18. Anadromous and catadromous fish committee.

Groot, S.J. de, 1992. Herstel van riviertrekvissen een realiteit? 8. De fint. De Levende Natuur 93(6), 182-186.

Groot, S.J. de, 2002. A review of the past and present status of anadromous fish species in the Netherlands: is restocking the Rhine feasible? Hydrobiologia 478, 205-218.

Grootjans, A.P., Engelmoer, M., Hendriksma, P. and Westhoff, V., 1988. Vegetation dynamics in a wet dune slack I: rare species decline on the Wadden island of Schiermonnikoog in The Netherlands. Acta Bot. Neerl. 37: 265-278.

Grootjans, A.P., Sival, F.P. and Stuyfzand, P.J., 1996. Hydro-geochemical analysis of a degraded dune slack. Vegetatio 126: 27-38.

Grootjans, A.P., Jong, J.W. de and Janssen, J.A.M., 1999. Slufters en Rode Lijstsoorten op Schiermonnikoog. Een analyse van de vegetatieontwikkelingen in de Strandvlakte en het gebied rond de Oosterduinen tussen 1958 en 1994. Laboratorium voor Plantenoecologie, Rijksuniversiteit Groningen.

Grootjans, A.P., Geelen, H.W.T., Jansen, A.J.M. and Lammerts, E.J., 2002. Restoration of coastal dune slacks in The Netherlands. Hydrobiologia 478: 181-203.

Grotjahn, M., 2000. Benthosbiologische Untersuchungen im Zusammenhang mit der Sicherung der Hafenzufahrt Hooksiel. Erste Ergebnisse hinsichtlich der aktuellen Besiedlung mit *Sabellaria spinulosa*. Forschungsber. i. A. Niedersächsisches Hafenamt Wilhelmshaven, unpubl. report.

Günther, K., 1998. Pallas-Bilanz für die Vögel: Folgenschwerste Ölpest im Wattenmeer. Berichte zum Vogelschutz, 36, 127.

Günther, K., 2003. Rastvogel Monitoring im Schleswig-Holsteinischen Wattenmeer 2001-2002. WWF, Husum.

Gutter, M.J., Loomans, P.M., Eijkelhof, W.F.M. and Knotters, A.G., 1997. Ameland-Oost, vegetatiekartering. Meetkundige Dienst, Rijkswaterstaat.

HABAK, 1999. Directive for dredged material management in Federal Coastal Waterways (HABAK-WSV). Second revised revision, June 1999. BfG-No. 1100, Bundesanstalt für Gewässerkunde, Koblenz, 32 pp.

Hagena, W., 2000. Die Kleine Hochsee- und Küstenfischerei Niedersachsens und Bremens im Jahr 1999. Das Fischerblatt, 2000/Nr. 3, 89-109.

Hahn, D., 2005. Neophythen der Ostfriesischen Inseln. Verbreitung, Ökologie und Vergesellschaftung. Ph.D. thesis, Univ. Hannover.

Hak, J., 2003. Toename lozingen paraffine en chemicaliën. Nieuwsbrief Beheersvisie Noordzee 2010 (6), 4-5.

Hälterlein, B., Fleet, D.M., Henneberg, H.R., Mennebäck, T., Rasmussen, L-M., Südbeck, P., Thorup, O. and Vogel, R.L., 1995. Anleitung zur Brutbestandserfassungen von Küstenvögeln im Wattenmeerbereich. Wadden Sea Ecosystem No. 3. Common Wadden Sea Secretariat, Wilhelmshaven.

Hälterlein, B., 1996. Brutvogelbestände im Schleswig-Holsteinischen Wattenmeer. Nationalparkamt, Tönning/Bundesumweltamt, Berlin.

Hälterlein, B., 1998. Brutvogelbestände im Schleswig-Holsteinischen Wattenmeer. UBA-Texte 76-97. Umweltbundesamt, Berlin.

Hälterlein, B., Südbeck, P., Knief, W. and Köppen, U., 2000. Brutbestandsentwicklung der Küstenvögel an Nord- und Ostsee unter besonderer Berücksichtigung der 1990er Jahre. Vogelwelt 112, 241-267.

Hälterlein, B., Bunje J., and Potel, P., 2003. Zum Einfluß der Salzwiesennutzung an der Nordseeküste auf die Vogelwelt - Übersicht über die aktuellen Forschungsergebnisse. Vogelkdl. Ber. Niedersachs. 35, 179 - 186.

Hammond, P.S., Berggren, P., Benke, H., Borchers, D.L., Collet, A., Heide-Jørgensen, M.P., Heimlich-Boran, S., Hiby, A.R., Leopold, M.F. and Øien, N., 2002. Abundance of harbour porpoise and other cetaceans in the North Sea and adjacent waters. J. Appl. Ecol. 39, 361-376.

Harding, K.C., Härkönen, T. and Caswell, H., 2002. The 2002 European seal plague: Epidemiology and population consequences. Ecol. Letters 5, 727-732.

Harding, K.C., Härkönen, T. and Pineda, J., 2003. Estimating quasi-extinction risk of European harbour seals: a reply to Lonergan and Harwood. Ecol. Letters 6, 894-897.

Härkönen, T. et al. Review of the seal epizootics in Europe.

Härkönen, T., Harding, K.C. and Heide-Jørgenssen, M.-P., 2002. Rates of increase in age structured populations, a lesson from the European harbour seal. Can. J. Zool. 80, 1498–1510.

Harrer, B. and Scherr, S., 2002. Ausgaben der Übernachtungsgäste in Deutschland. dwif Schriftenreihe Nr. 49. München, 172 pp.

Hartog, C. den, and Polderman, P.J.G., 1975. Changes in the seagrass populations of the Dutch Waddenzee. Aquat Bot 1: 141-147.

Hartog, C. den, and Phillips, R.C., 2001. Common structures and properties of seagrass beds fringing the coasts of the world. In: Reise, K., (Ed.). Ecological comparisons of sedimentary shores. Ecological Studies 151. Springer-Verlag, Berlin Heidelberg: 195-212.

Hartog, P.S., Everts, F.H., Grootjans, A.P. and de Vries, N.P.J., 1991. Vegetatiekartering van de Mokslootvallei (Texel). Bureau Everts and De Vries, Groningen. Rapportnummer EV 91/8.

Heineke, M., Sombrowski, W. and Vorberg, R., 2002. Erste Testmessungen zur Standortermittlung und Ausdehnung von Sandkorallenriffen im Rütergat mittels Fächerecholottechnik. GKSS-Forschungszentrum Geesthacht GmbH, Institut für Küstenforschung, Abteilung Küstenozeanographische Messsysteme, unpubl. report.

Heineke, M., Schomann, H., Sombrowski, W. and Vorberg, R., 2003. Fächerecholottechnik zur Sedimenterkennung – Machbarkeitsstudie an ausgewählten Standorten im Hörnum Tief. GKSS-Forschungszentrum Geesthacht GmbH, Institut für Küstenforschung, Abteilung Küstenozeanographische Messsysteme, unpubl. report.

Hellwig-Krüger, L. and Hellwig, U., 1995. Biotoptypenkartierung Neuwerk. In: Nationalpark Hamburgisches Wattenmeer - Nationalpark-Plan. Arbeitsabschnitt 1995. pp. 54. unpublished survey.

Hellwig-Krüger, L. and Hellwig, U., 1997. Biotoptypenkartierung Scharhörn und Nigehörn. In: Nationalpark Hamburgisches Wattenmeer - Nationalpark-Plan. Arbeitsabschnitt 1997. pp. 88. unpublished survey.

Hennig, V., K. Eskildsen, 2001. Notwendigkeit ungestörter Mausergebiete für die Trauerente (*Melanitta nigra*). P. 70-71 in Landesamt für den Nationalpark Schleswig-Holsteinisches Wattenmeer (Eds.): Wattenmeermonitoring 2000. Schriftenreihe, Sonderheft, Tönning.

Herlyn, M. and Millat, G., 2000. Decline of the intertidal blue mussel (*Mytilus edulis*) stock at the coast of Lower Saxony (Wadden Sea) and influence of mussel fishery on the development of young mussel beds. Hydrobiologia 426: 203-210.

Herlyn, M. and Millat, G., 2004. Wissenschaftliche Begleituntersuchungen zur Aufbauphase des Miesmuschelmanagements im Nationalpark „Niedersächsisches Wattenmeer“ Projekt der Niedersächsischen WattenmeerStiftung, Nr. 32/98. Abschlussbericht März 2004,

Bezirksregierung Weser-Ems Niedersächsisches Nationalparkverwaltung, Wilhelmshaven, Landesamt für Ökologie, Forschungsstelle Küste, Norderney, pp. 238.

Herlyn, M., 2005. Quantitative assessment of intertidal blue mussel (Mytilus edulis L.) stocks: combined methods of remote sensing, field investigation and sampling. J. Sea Res. 53 (in press).

Heubeck, M., Camphuysen, C.J., Bao, R., Humple, D., Sandoval, A., Cadiou, B., Bräger, S. and Thomas, T., 2003. Assessing the impact of major oil spills on seabird populations. Mar. Poll. Bull. 46, 900-902.

Heydemann, B., 1981. Ecology of arthropods of the lower salt marsh. In: Dankers, N, Kühl, H. and Wolff, W.J. (Eds.). Invertebrate fauna of the Wadden Sea. Report 4 of the Wadden Sea Working Group. Balkema, Rotterdam, pp. 35 – 57.

Hickel, W., 1989. Inorganic micronutrients and the eutrophication in the Wadden Sea of Sylt (German Bight, North Sea). Proceedings of the 21st EMBS. Polish Academy of Science, Gdansk, p. 309-318.

Hiddink J.G., Marijnissen SAE, Troost K, Wolff WJ 2002. Predation on 0-group and older yearclasses of the bivalve *Macoma balthica*: interaction of size selection and intertidal distribution of epibenthic predators. J Exp Mar Biol Ecol 269: 233-248.

Hiddink, J.G. and Wolff, W.J. 2002. Changes in the distribution and decrease in numbers during migration of the bivalve *Macoma balthica*. Mar Ecol Progr Ser 233: 117-130.

Hiddink, J.G., 2003. Effects of suction-dredging for cockles on non-target fauna in the Wadden Sea. J. Sea Res 50: 315-323.

Hobohm, C., 1993. Die Pflanzengesellschaften von Norderney. Arbeiten aus der Forschungsstelle Küste 12. Niedersächsisches Landesamt für Ökologie, pp. 202.

Hoeksema, H.J., Mulder, H.P.J., Rommel, M.C.,deRonde, J.G. and de Vlas, J., 2004. Bodemdalingsstudie Waddenzee 2004. Vragen en onzekerheden opnieuw beschouwd. Rijksinstituut voor Kust en Zee/RIKZ, Rapport RIKZ/2004.025, 1-138. Den Haag.

Hofstede, J.L.A., 1991. Sea level rise in the inner German Bight (Germany) since AD 600 and its implications upon tidal flats geomorphology. In: Brückner, H. and Radtke, U. (Eds.). From the North Sea to the Indian Ocean. Franz Steiner Verlag, Stuttgart, pp. 11-27.

Hofstede, J.L.A., 1999a. Process-response analysis for Hörnum tidal inlet in the German sector of the Wadden Sea. Quat. Internat. 60:107-117.

Hofstede, J.L.A., 1999b. Mögliche Auswirkungen eines Klimawandels im Wattenmeer. Petermanns Geogr. Mitt. 143: 305-314.

Hofstede, J.L.A., 2003. Integrated management of artificially created salt marshes in the Wadden Sea of Schleswig-Holstein, Germany. Wetlands Ecology and Management 11/3, 183-194.

Hötker, H. and Segebade, A., 2000. Effects of predation and weather on the breeding success of Avocets *Recurvirostra avosetta*. Bird Study 47, 91-101.

Hötker, H. and West, R., 2005. Population size, population development and habitat use by Avocets in Western Europe at the end of the 20th century. Wader Study Group Bulletin 107, 57-65.

Hubold, G. and Ehrich, S., 2001. Bedrohte Meeresfischarten wieder häufiger. Presseinformation Nr. 359 vom 12.12.2001, Inst. f. Seefischerei der Bundesforschungsanstalt für Fischerei, Hamburg.

Hughes, R.G., Lloyd, D., Ball, L. and Emson, D., 2000. The effects of the polychaete Nereis diversicolor on the distribution and transplanting success of Zostera noltii. Helgol. Mar. Res. 54: 129-136.

Hughes, R.G. 2004. Climate change and loss of saltmarshes: consequences for birds. Ibis 146 (suppl. 1), 21-28.

Hummel, H., 2003. Geographical patterns of dominant bivalves and a polychaete in Europe: no metapopulations in the marine coastal zone? Helgol Mar Res 56: 247-251.

ICES, 2003. Report of the working group on Crangon fisheries and life history. ICES CM 2003/G:01, 56 pp.

IRWC, 2000a. Sustainable Tourism Development and Recreational Use in the Wadden Sea Region. NetForum, Final Report. Inter-regional Wadden Sea Cooperation, Ribe County, Denmark.

Jager, Z., 1999. Processes of tidal transport and accumulation of larval flounder (Platichthys flesus L.) in the Ems-Dollard nursery. Ph.D. thesis University Amsterdam, ISBN 90-9012525-6.

Janssen, J., 2001. Mapping of salt marsh vegetation by sequential mapping. Rijskwaterstaat Meetkundige Dienst Delft, pp. 249.

Janssen, G.M. and Mulder, S., 2004. 'Het strand van Nederland'. Onderzoek naar de ecologie van het natte strand. Rijksinstituut voor Kust en Zee/RIKZ, Report RIKZ-2004.033.

Janssen-Stelder, B.M., 2000. A System analysis of salt marsh development along the mainland coast of the Dutch Wadden Sea. Utrecht University, Ph.D. thesis, 103 pp.

Jensen, A.R., Nielsen, H.T. and Ejbye-Ernst, M., 2003. National Management Plan for the Houting. Publ. by the Ministry of the Environment and Energy, the Forest and Nature Agency, the County of Sønderjylland and the County of Ribe, pp. 34.

Joensen, A.H., 1972a. Oil pollution and seabirds in Denmark 1935-1968. Dan. Rev. Game Biol. 6(8), 1-24.

Joensen, A.H., 1972b. Studies on Oil pollution and seabirds in Denmark 1968-1971. Dan. Rev. Game Biol. 6(9), 1-32.

Joensen, A.H., and Hansen, E.B., 1977. Oil pollution and seabirds in Denmark 1971-1976. Dan. Rev. Game Biol. 10(5), 1-31.

Joint Progress Report 2001. Implementation of the Stade Declaration and the Trilateral Wadden Sea Plan. 9th Trilateral Governmental Conference, Esbjerg, October 31, 2001.

Jong, D.J. de, Dijkema, K.S., Bossinade, J.H. and Janssen, J.A.M., 1998. SALT97, een programma voor toedeling van vegetatieopnamen aan vegetatietypen op de kwelder. Rijkswaterstaat (RIKZ, directie Noord-Nederland, Meetkundige Dienst) / Instituut voor Bos and Natuuronderzoek, Middelburg/Texel.

Jong, F. de., 1992. The wise-use concept as a basis for the conservation and management of the Wadden Sea. International Journal of Estuarine and Coastal Law 7(3): 175–195, 1992.

Jong, F. de., 1993. Water quality of the Wadden Sea. In: Hillen R, Verhagen HJ (eds) Coastlines of the Southern North Sea. American Society of Civil Engineers, New York. pp 162-177

Jong, F. de., 1994. International environmental protection of the Wadden Sea and the North Sea and the integration of pollution and conservation policies. Ophelia Suppl 6: 37–45, 1994.

Jong, F. de., 1998. Marine ecological quality objectives: Science and management aspects. In: Müller F, Leupelt M (eds) Eco-Targets, Goal Functions and Orientors. Springer, Berlin, Heidelberg. pp 526–544

Jong, F. de, 2003. Wadden Sea targets: lessons from the first six years. pp. 207-220 in: Wolff WJ, Essink K, Kellermann A, Van Leeuw MA (Eds.). Challenges to the Wadden Sea Area. Proceedings of the 10th International Scientific Wadden Sea Symposium. Ministry of

Agriculture Nature Management and Fisheries, Department of Marine Biology, University of Groningen, Netherlands.

Jong, F. de., 2004. Ökologisch Qualitätsziele im integrierten Ökosysem Management des Wattenmeers und der Nordsee. In: Wiggering H, Müller F (Hrsg) Umweltziele und Indikatoren. Springer, Berlin, Heidelberg. S. 451-477.

Jong, F. de., 2006. Nature conservation and coastal development: a(n) (un)happy marriage? The case of the international Wadden Sea. In: Tubielewicz A (Ed) Living Marine Resources and Coastal Habitats. Littoral 2006 Conference. Gdanks University of Technology, Gdansk, Poland. pp. 77-84

Jong, F. de, Bakker, J.F., Dahl, K., Dankers, N., Farke, H., Jäppelt, W., Kossmagk-Stephan, K. and Madsen, P.B., 1993. Quality status report of the North Sea, Sub region 10, The Wadden Sea. Common Wadden Sea Secretariat, Wilhelmshaven, pp. 107.

Jong, F. de, Bakker, J.F., van Berkel, C.J.M., Dankers, N.M.J.A., Dahl, K., Gätje, C., Marencic, H. and Potel, P., 1999. Wadden Sea Quality Status Report. Wadden Sea Ecosystem No 9. Common Wadden Sea Secretariat, Wilhelmshaven, Germany.

Jonge, V. N., de and Postma, H., 1974. Phosphorus compounds in the Dutch Wadden Sea. Neth. J. Sea Res. 8: 139-153.

Jonge, V.N. de and de Jong, D.J., 1992. Role of tide, light and fisheries in the decline of Zostera marina L. in the Dutch Wadden Sea. Neth. Inst. Sea Res. Publ. Ser. 20: 161-176

Jonge, V.N. de, Essink, K. and Boddeke, R., 1993. The Dutch Wadden Sea: A changed ecosystem. Hydrobiologia 265, 45-71.

Jonge, V.N. de, and de Jong, D.J., 2002. 'Global change' impact of inter-annual variation in water discharge as a driving factor to dredging and spoil disposal in the River Rhine system and of turbidity in the Wadden Sea. Est. Coast Shelf. Sci. 55:969-991.

Jonker N., Laane R.W.P.M. and de Voogt, P., 2004. Sources and fate of nonylphenol ethoxylates and their metabolites in the Dutch coastal zone of the North Sea. Mar. Chem., in press.

Kamermans, P., Schuiling, E, Baars, D. and van Riet, M., 2003. EVA II project A1: Visserijinspanning. Rijksinstituut voor Visserijonderzoek (RIVO), rapport C057/03, Yerseke.

Kastler, T. and Michaelis, H., 1999. The decline of seagrasses, *Zostera marina* and *Zostera noltii*, in the Wadden Sea of Lower Saxony. Senckenbergiana marit. 29:77-80.

Kater, B., Hannewijk, A. and Schout, P., 2000. Bioassays in seven sediment samples of the Sea harbour channel. Internal document RIKZ/OS/2000/x, (in Dutch).

Kats, R. K. H., 2007. Common Eiders *Somateria mollissima* in the Netherlands: The rise and fall of breeding and wintering populations in relation to the stocks of shellfish. PhD thesis, University of Groningen.

Katwijk, M.M. van, Schmitz, G.H.W., Gasseling, A.P. and van Avesaath, P.H., 1999. Effects of salinity and nutrient load and their interaction on Zostera marina. Mar. Ecol. Prog. Ser. 190: 155-165.

Katwijk, M.M. and Hermus, D.C.R., 2000. Effects of water dynamics on Zostera marina transplantation experiments in the intertidal Dutch Wadden Sea. Mar. Ecol. Prog. Ser. 208: 107-118.

Katwijk, M.M. van, Hermus, D.C.R, de Jong, D.J., Asmus, R.M. and de Jonge, V.N., 2000. Habitat suitability of the Wadden Sea for restoration of *Zostera marina* beds. Helgol. Mar. Res. 54: 117-128.

Katwijk, M.M. van, 2003. Reintroduction of eelgrass (*Zostera marina* L.) in the Dutch Wadden Sea: a research overview and management vision. In: Wolff, W.J., Essink, K., Kellermann,

A., and van Leeuwe, M.A., (Eds.). Challenges to the Wadden Sea. Ministry of Agriculture, Nature Management and Fisheries, Dept North, Groningen, 173-195.

Katwijk, M.M. van, and Wijgergangs, L.J.M., 2004. Effects of locally varying exposure, sediment type and low-tide water cover on Zostera marina recruitment from seed. Aquat. Bot. 80(1): 1-12.

Kempf, N., 1999. Räumliche und zeitliche Verteilung vn Brandenten zur Mauserzeit im Wattenmeer 1999. Unveröff. Gutachten im Auftrag der RWE-DEA Aktiengesellschaft für Mineralöl und Chemie, Hamburg.

Kempf, N., 2001. Eiderenten und mausernde Brandenten im schleswig-holsteinischen Wattenmeer 2000. P. 68-69 in Landesamt für den Nationalpark Schleswig-Holsteinisches Wattenmeer (Hrsg.): Wattenmeermonitoring 2000. Schriftenreihe, Sonderheft, Tönning.

Kempf, N., 2004. Eiderenten und mausernde Brandenten im schleswig-holsteinischen Wattenmeer im Jahr 2004. Gutachten im Auftrag des Landesamtes für den Nationalpark Schleswig-Holsteinisches Wattenmeer, Tönning.

Kempf, N., 2005. Eiderenten und mausernde Brandenten im schleswig-holsteinischen Wattenmeer im Jahr 2005. . Gutachten im Auftrag des Landesamtes für den Nationalpark Schleswig-Holsteinisches Wattenmeer, Tönning.

Kempf, N., 2006. Eiderenten und mausernde Brandenten im schleswig-holsteinischen Wattenmeer im Jahr 2006. Gutachten im Auftrag des Landesamtes für den Nationalpark Schleswig-Holsteinisches Wattenmeer, Tönning.

Kersten, M., 2004. Aantallen en bescherming van strandbroeders op bewoonde waddeneilanden: tussentijdse rapportage 2004. Natuurcentrum Ameland.

Ketner-Oostra, R. and Loo, H. van der, 1998. Is lichen-rich dry dune grassland (Violo-Corynephoretum dunense) on the verge of disappearing from the West-frisian Islands, through aerial eutrophication? Senckenb. Marit. 29: 45-49.

Ketner-Oostra, R. and Sýkora, K.V., 2004. Decline of lichen-diversity in calcium-poor coastal dune vegetation since the 1970's, related to grass and moss encroachment. Phytocoenologia 34/4.

Ketzenberg, C., 1993. Auswirkungen von Störungen auf nahrungssuchende Eiderenten (*Somateria mollissima)* im Königshafen/Sylt. Corax, 15, 241-244.

Kiehl, K., Jensen, K. and Stock, M., 2003. Langfristige Vegetationsveränderungen in Wattenmeer-Salzwiesen in Abhängigkeit von Höhenlage und Sedimentation. Kieler Notizen zur Pflanzenkunde in Schleswig-Holstein und Hamburg 30: 50-68.

Kingston, P.F., 1992. Impact of offshore oil production installations on the benthos of the North Sea. ICES J. mar. Sci. 49, 45-53.

Kinze, C.C., Jensen, T. and Skov, R., 2003. Focus på hvaler i Danmark 2000-2002. Biological papers No. 2, Fisheries and Maritime Museum, Esbjerg, Denmark, pp. 47.

Kipp, M., 1982. Ergebnisse individueller Farbberingung beim Grossen Brachvogel und ihre Bedeutung für den Biotopschutz.- Beih. Veröff. Narturschutz Landschfatspflege Bad.-Württ. 25: 113-118.

Klaassen, M., Bauer, S., Madsen, J. and Tombre, I., 2006. Modelling behavioural and fitness consequences of disturbance for geese along their spring flyway. - Journal of Applied Ecology 43, 92-100.

Klaassen-Bos, K., 2005. The breeding success of Avocets *Recurvirostra avosetta* in the Dollard, The Netherlands. MsC Report, Wageningen University/SOVON. Wageningen/Beek-Ubbergen.

Klamer, J.C., Leonards, P.E.G., Lamoree, M.H., and Bakker, J.F., 2002. Chemical and toxicological risk assessment of North Sea surface sediments. Brominated flame retardants and dioxin-type toxicity. Organohal. Comp. 59:111-114.

Klamer, J.C., Jorritsma, J., van Vliet, L., Smedes, F. and Bakker, J.F., 2004. Dioxin-type toxicity in harbour dredging material of the sea harbour channel of Delfzijl (The Netherlands). RIKZ report 2004.013 (in Dutch).

Kleef, H.L. and Jager, Z., 2002. Het diadrome visbestand in het Eems-Dollard estuarium in de periode 1999 tot 2001. Rapport RIKZ/2002.060. Rijksinstituut voor Kust en Zee, Haren.

Kleyer, M., Feddersen, H. and Bockholt, R., 2003. Secondary succession on a high salt marsh at different grazing intensities. J. Coastal Conservation 9: 123-134.

Klok, E.J., 1998. Indices die de variabiliteit en de extremen van het klimaat beschrijven. Klimatol Dienstverl KNMI, De Bilt. Technical report TR-211, 50 pp.

Kloppmann, M.H.F., Böttcher, U., Damm, U., Ehrich, S., Mieske, B., Schultz, N. and Zumholz, K., 2003. Erfassung von FFH-Anhang II-Fischarten in der deutschen AWZ der Nord- und Ostsee. Bericht i. A. des Bundesamtes für Naturschutz, F+E-Vorhaben FKZ: 802 85 200, Bundesforschungsanstalt für Fischerei, Hamburg und Rostock, pp. 82.

Knijn, R. J., Boon, T.W., Heessen, H.J.L. and Hislop, J.R.G., 1993. Atlas of North Sea Fishes. ICES cooperative research report. No. 194.

Koffijberg, K., Blew J., Eskildsen, K., Günther, K., Koks, B., Laursen, K., Rasmussen, L.-M., Südbeck, P. and Potel, P., 2003. High tide roosts in the Wadden Sea: A review of bird distribution, protection regimes and potential sources of anthropogenic disturbance. A report of the Wadden Sea Plan Project 34. Wadden Sea Ecosystems No. 16, Common Wadden Sea Secretariat, Trilateral Monitoring and Assessment Group, JMMB Wilhelmshaven, Germany, pp. 119.

Koffijberg, K. and Günther, K. 2005. Recent population dynamics and habitat use of Barnacle Geese and Dark-bellied Brent Geese in the Wadden Sea. P. 00-00 in Blew, J. and Südbeck, P. (Eds) 2005: Migratory waterbirds in the Waddensea 1992/1993-1999/2000. Wadden Sea Ecosystem No. 20, Common Wadden Sea Secretariat, Wilhelmshaven, Germany.

Koffijberg, K., Dijksen, L., Hälterlein, B., Laursen, K., Oltmanns, B., Potel, P., Südbeck, P. and Thorup, O., 2005b. Highlights of breeding birds in the Wadden Sea in 2003-2004. Wadden Sea Newsletter 2005-1, 11-25.

Koffijberg, K., Dijksen, L., Hälterlein, B., Koffijberg, K., Laursen, K., Potel, P. and Südbeck, P. (Eds.) 2006. Breeding Birds in the Wadden Sea in 2001. Results of a total survey in 2001 and trends in numbers between 1990-2001. Wadden Sea Ecosystem No. 22; Common Wadden Sea Secretariat, Trilateral Monitoring and Assessment Group, Joint Monitoring Group of Breeding Birds in the Wadden Sea, Wilhelmshaven, Germany. pp. 136.

Kok, J. de, 2005. Morfologische effecten van de Eijerlandse dam. Rijkswaterstaat, Rijksinstituut voor Kust en Zee/RIKZ, Den Haag. Report 2005.003 (in press).

Koks, B.J. and Hustings, F., 1998. Broedvogelmonitoring in het Nederlandse Waddengebied in 1995 en 1996. Sovon-monitoringrapport 1998/05. SOVON, Beek-Ubbergen.

Kolbe, K., Kaminski, E., Michaelis, H., Obert, B. and Rahmel, J., 1995. Macroalgal mass development in the Wadden Sea: first experiences with a monitoring system. Helgoländer Meeresunters. 49, 519-528.

Koopman, K., 2003. De balans van 20 jaar ringonderzoek aan broedvogels bij Holwerd. Twirre 14 (3), 73-80.

Koopmann, C., Faller, J., Bernem, K.-H. van, Prange, A. and Müller, A., 1993. Schadstoffkartierung in Sedimenten des deutschen Wattenmeeres Juni 1989-Juni 1992. GKSS 88.156.

Koppel, J. van de, Herman, P.M.J., Thoolen, P. and Heip, C.H.R., 2001. Do alternate stable states occur in natural ecosystems? Evidence from a tidal flat. Ecology 82: 3449-3461.

Körner, D and Weichert, G., 1992. Nutrients in the German Bight: Concentrations and trends. ICES Mar. Sci. Symp. 195: 159-176.

Kraan, C., T. Piersma, A. Dekinga, J. van der Meer, J. van Gils, B. Spaans, A. Koolhaas, C. Raaijmakers, 2004. Korte termijn effecten van de mechanische kokkelvisserij in de westelijke Waddenzee op bodemfauna. Koninklijk Nederlands Instituut voor Onderzoek der Zee, Texel, Koninklijk NIOZ-Intern Rapport, 1-20.

Kraan, C., Piersma, T., Dekinga, A. and Fey, B. 2006. New moulting area for Shelduck *Tadorna tadorna* in the Dutch Wadden Sea offers plenty of mudshrimps Corophium volutator and little disturbance. Limosa, 79, 19-24.

Kraan, C., Piersma, T., Dekinga, A., Koolhaas, A. and van der Meer, J., 2007. Dredging for edible cockles (*Cerastoderma edule*) on intertidal flats: short-term consequences of fisher patch-choice decisions for target and non-target benthic fauna. – ICES Journal of Marine Science, 64: 1735–1742.

Kragtwijk, N.G., 2001. Aggregated scale modelling of tidal inlets of the Wadden Sea. WL | Delft Hydraulics/Delft Cluster, Report Z2822/DC03.01.03a.

Kristensen, P.S., 1994. Blåmuslingebestanden i det danske Vadehav og Blåmuslingefiskeri (1991-1993). DFH-rapport nr. 476-94, pp. 56.

Kristensen, P.S., 1995. Aerial surveys, biomass estimates, and elimination of the mussel population (Mytilus edulis L.), in the Danish Wadden Sea, 1991-1994. ICES, Shellfish Committee, C.M. 1995/K: 44, pp. 22.

Kristensen, P. S, 1997. Blåmuslingebestanden i det danske Vadehav august 1996. DFU-rapport nr. 36-97, pp. 27.

Kristensen, P.S. and N. J. Pihl., 2003. Blåmuslingebestanden i det danske Vadehav efteråret 2002. DFU-rapport nr. 122-03, pp 35.

Kristensen, P. S. & N. J. Pihl., 2006. Blåmuslinge- og stillehavsøstersbestanden i det danske Vadehav efteåret 2006. DFU-rapport nr. 167-06

Krol, J., 2005. Strandbroeders: rapportage broedseizoen 2005. Natuurcentrum Ameland, Ameland.

Kröncke, I., 1996. Impact of biodeposition on macrofaunal communities in intertidal sandflats. PSZNI: Marine Ecology 17: 159-174.

Kröncke, I., Zeis, B. and Rensing, C., 2001. Long-term variability in macrofauna species composition off the island of Norderney (East Frisia, Germany) in relation to changes in climatic and environmental conditions. Senckenbergiana Marit. 31: 65-82.

Krüger, T., Burdorf, K. and Südbeck, P., 2003. Erfordernisse zur Identifizierung von Europäischen Vogelschutzgebieten in der 12-Seemeilen-Zone Niedersachsens. In: NNA (Eds.). Offshore-Windparks und Naturschutz-Konzepte und Entwicklungen. NNA-Ber. 3/2003, 47-64.

Kubetzki, U. and Garthe, S., 2003. Distribution, diet and habitat selection by four sympatrically breeding gull species in the South-eastern North Sea. Marine Biology 143, 199-207.

Kühl, H., 1961. Nahrungsuntersuchungen an einigen Fischen im Elbe-Mündungsgebiet. Berichte der Deutschen Wissenschaftlichen Kommission für Meeresforschung 16(2), 90-104.

Kuijper, D.P.J. and Bakker, J.P., 2003. Large-scale effects of a small herbivore on salt marsh vegetation succession - A comparative study on three Wadden Sea islands. J. Coastal Conservation 9: 179-188.

Kuiper, W., 2000. De weekdieren van de Nederlandse Brakwatergebieden (Mollusca). Nederl. Faun Meded 12: 41-120.

Laane, R.W.P.M., 1992. Background concentrations of natural compounds. Report DGW-92.033, Den Haag (NL), pp. 84.

Lammerts, E.J., Sival, F.P., Grootjans, A.P. and Esselink, H., 1992. Hydrological conditions and soil buffering processes controlling the occurrence of dune slacks species on the Dutch Wadden Sea islands. In: Carter, R.W.G., Curtis, T.G.F. and Sheehy-Skeffington, M.J. (Eds.): Coastal Dunes: Geomorphology, Ecology and Management for Conservation. Proceedings of the Third European Dune Congress, Galway, Ireland, pp.265-272. A.A. Balkema, Rotterdam.

Lammerts, E.J., 1999. Basiphilous pioneer vegetation in dune slacks on the Dutch Wadden Sea islands. Ph.D. thesis, Univ. Groningen.

Langenberg, H., Pfizenmay, A., von Storch, H. and Föndermann, J., 1999. Storm-related sea level variations along the North Sea coast: Natural variability and anthropogenic change. Continental Shelf Res. 19: 821-842.

Langgemach, T. and Bellebaum, J., 2005. Prädation und Schutz bodenbrütender Vogelarten in Deutschland. Die Vogelwelt 126, 259-298.

Laursen, K. and Frikke, J., 1987. Winter counts of seabirds off the southwest coast of Denmark. Dansk Ornitologisk Forenings Tidskrift 81, 167-172.

Laursen, K., J. Salvig, J. Frikke, 1997. Vandfugle i relation til menneskelig aktivitet i vadehavet 1980-1995. DMU-rapport 187. DMU, Kalø.

Laursen, K., Pihl, S., Durinck, J. Hansen, M., Skov, H., Frikke, J. and Danielsen, F., 1997. Numbers and Distribution of Waterbirds in Denmark 1987-1989. Danish Review of Game Biology vol. 15, no.1, 181 pp.

Laursen, K., 2002. Status of the management of geese in the Wadden Sea region in 2001. Wadden Sea Newsletter, 27 (2), 14-19.

Laursen, K., 2005. Curlew in the international Wadden Sea - effects of shooting protection in Denmark. In: Blew, J. and P. Südbeck (Eds.). Migratory waterbirds in the Wadden Sea 1980-2000. Wadden Sea Ecosystem No. 20, Common Wadden Sea Secretariat, Trilateral Monitoring and Assessemnt Group, Joint Monitoring Group of Migratory Birds in the Wadden Sea, Wilhelmshaven, Germany.

Laursen, K., K. Kahlert and J. Frikke, 2005. Factors affecting escape distances of staging waterbirds. Wildlife Biology 11, 13-19.

Leeuw, G. de, Cohen, L.H., Frohn, L.M., Geernaert, G., Hertel, O., Jensen, B., Jickells, T., Klein, L., Kunz, G.J., Lund, S., Moermann, M.M., Müller, F., Pederson, B., Salzen, K. von, Schlünzen, K.H., Schulz M., Skjoth, C.A., Sorensen, L.L., Spokes, L., Tamm, S. and Vignati, E., 2001. Atmospheric input of nitrogen into the North Sea: ANICE project overview. Continental Shelf Research, 21, 2073-2094.

Lenhart, H.-J. and Pätsch, J., 2001. Daily nutrient loads of the European continental rivers for the years 1977-1998. Berichte aus dem Zentrum für Meeres- und Klimaforschung; Reihe B: Ozeanographie, No 40, pp. 146.

Leopold M.F., 1993. Spisula's, zeeëenden en kokkelvissers: een nieuw milieuprobleem op de Noordzee. Sula 7, 24-28.

Leopold, M.F., H. J. B. Baptist, P. A. Wolf, H. R. Offringa, 1995. De Zwarte Zee-Eend Melanitta nigra in Nederland. Limosa, 68, 49-64.

Leopold, M.F., M. A. van den Land, 1996. Fishermen and seaducks are moving towards sharing the Spisula resource in The Netherlands. Wadden Sea Newsletter, 1, 24-26.

Leopold, M.F., 2003. Opnieuw grote aantallen ruiende bergeenden in de Waddenzee gevonden. Nieuwsbrief NZG jaargang, 5 (1), 2-3.

Leopold, M.F., Smit, C.J., Goedhart, P.W., Roomen, M. van, Winden, E. van and Turnhout, C. van, 2004. Langjarige trends in aantallen wadvogels in relatie tot de kokkelvisserij en het gevoerde beleid in deze. EVAII deelrapport C2. Alterra, Wageningen, Alterra rapport 1-139.

Leopold M.F., E.M. Dijkman, J.S.M. Cremer, A. Meijboom, P.W. Goedhart, 2004b. De effecten van mechanische kokkelvisserij op de benthische macrofauna en hun habitat. EVAII deelproject C1/3. Alterra, Wageningen. Alterra rapport, 1-149.

Liebmann, F., 1999. Ringelganstage auf den Halligen ein voller Erfolg. In: Wattenmeer International, Husum, 17 (1-2), 18.

LNV, 2003. Results Scientific Research EVA II. Public Version. LNV Den Haag, March 2003, 37 p.

LNV, 2004: Ruimte voor een zilte oogst. Naar een omslag in de Nederlandse schelpdiercultuur. Beleidsbesluit Schelpdiervisserij 2005 – 2020. Ministerie van Landbouw, Natuur en Voedselkwaliteit, Den Haag, 1 Oktober 2004

Lozán, J.L., Breckling, P., Fonds, M., Krog, C., Veer, H.W. van der and Witte, J.J., 1994. Über die Bedeutung des Wattenmeeres für die Fischfauna und deren regionale Veränderung. In: Lozán, J.L., Rachor, E., Reise, K., Westernhagen, H. von and Lenz, W. (Eds.), 1994. Warnsignale aus dem Wattenmeer, Blackwell, Berlin, 226-234.

Lozán, J. and Kausch, H., 1996. Warnsignale aus Flüssen und Ästuaren. Parey Buchverlag Berlin, pp. 390.

Lozan, J.L., Rachor, E., Reise, K., Sündermann, J. and Westenhagen, H.v., 2002. Warnsignale aus Nordsee und Wattenmeer eine aktuelle Umweltbilanz. Wissenschaftliche Auswertungen, Hamburg.

Lutz, K., P. Südbeck, B. Hälterlein, M. Stock, 2003. Die Europäischen Naturschutzrichtlinien: Verpflichtung zur Pflege und zur freien Sukzession der Salzwiesen an der Nordseeküste?. Vogelkundliche Berichte aus Niedersachsen, 35 (2), 91-102.

Maarel, E. van der and van der Maarel-Versluys, M., 1996. Distribution and conservation status of littoral vascular plant species along the European coasts. J. Coastal Conservation 2: 73-92.

Madsen, J., 1985. Impact of disturbance on field utilisation of pink-footed geese in West-Jutland, Denmark. Biol. Cons., 33, 53-63.

Madsen, J., 1988. Autumn feeding ecology of herbivorous wildfowl in the Danish Wadden Sea and impact of food supplies and shooting on movements. Danish Review of Game Biology, 13, 2-31.

Madsen, J., Cracknell, G. and Fox, T. (Eds.), 1999. Goose population of the Western Palearctic. A review of status and distribution. Wetland International, Wageningen, pp. 344.

Madsen, J., 2007. Possible effects and impacts of recreational activities on bird populations in the Wadden Sea – can disturbance explain the negative trends? In: Reineking, B. and Südbeck, P. (Eds.). Seriously declining trends in migratory waterbirds: Causes-Concerns-Consequences. Proceedings of the International Workshop on 31 August 2006 in Wilhelmshaven, Germany. Wadden Sea Ecosystems No. 23. Common Wadden Sea Secretariat, Wadden Sea National Park of Lower Saxony, Institute of Avian Research, Joint Monitoring Group of Migratory Birds in the Wadden Sea, Wilhelmshaven, Germany, p. 65 – 68.

Mai, S. and Bartholomä, A., 2000. The missing mud flats of the Wadden Sea: a reconstruction of sediments and accommodation space lost in the wake of land reclamation. In: Flemming, B.W., Delafontaine, M.T. and Liebezeit, G., (Eds.). Muddy coast dynamics and resource management. Elsevier Science, pp. 257-272.

Maitland, P.S. and Hatton-Ellis, T.W, 2003. Ecology of the Allis and Twaite Shad. Conserving Natura 2000 Rivers Ecology Series No.3, English Nature, Peterborough.

Marencic, H., Bakker, J., Farke, H., Gätje, C., de Jong, F., Kellermann, A., Laursen, K., Pedersen, T.F. and J. de Vlas, 1996. The Trilateral Monitoring and Assessment Program (TMAP). Expert Workshops 1995/96. Wadden Sea Ecosystem No. 6. - Common Wadden Sea Secretariat and Trilateral Monitoring and Assessment Group, Wilhelmshaven, Germany.

Marencic, H. 1997. The Trilateral Monitoring and Assessment Program (TMAP) of the Wadden Sea. Natur und Landschaft : Zeitschrift für Naturschutz und Landschaftspflege, Vol. 72, Heft: 11, S: 507-512.

Marencic, Harald, 2003. Trilaterales Wattenmeermonitoring und Salzwiesenmanagement. Vogelkundliche Berichte aus Niedersachsen. Vol. 35, Heft 2, S: 103-108

Marencic, Harald; Essink, Karel, 2004. The EU Water Framework Directive - implications for the Wadden Sea. Wadden Sea Newsletter 2004 - 1 (30), pp 5-7

Martin, J. M. and Brun-Cottan, J. C., 1988. Estuaries. In: Salomons, W., Bayne, B.L., Duursma, E.K., Förstner, U. (Eds.). Pollution of the North Sea. Springer-Verlag, Berlin, pp. 88-99.

Melter, J., Südbeck, P., Fleet, D.M., Rasmussen, L-M. and Vogel, R.L., 1997. Changes in breeding bird numbers in census areas in the Wadden Sea 1990 until 1994. Wadden Sea Ecosystem No. 4. Common Wadden Sea Secretariat, Wilhelmshaven.

Melter, J., 2004. Bestandssituation der Wiesenlimikolen in Niedersachsen. In: Krüger, T. and Südbeck, P. (Eds.), Wiesenvogelschutz in Niedersachsen. Naturschutz Landschaftspfl. Niedersachs. 41, 10-23.

Meltofte, H., Blew, J., Frikke, J., Rösner, H.-U. and Smit, C.J., 1994. Numbers and distribution of waterbirds in the Wadden Sea. Results and evaluation of 36 simultaneous counts in the Dutch-German-Danish Wadden Sea 1980-1991. IWRB Publ. 34 / Wader Study Group Bull. 74, Special Issue. Common Wadden Sea Secretariat, Wilhelmshaven, pp. 192.

Menn, I., 2002a. Ecological comparison of two sandy shores with different morphodynamics in the North Sea. Reports on Polar and Marine Research 417: 1-170.

Menn, I., 2002b. Beach morphology and food web structure: comparison of an eroding and an accreting sandy shore in the North Sea. Helgol. Mar. Res. 56: 177-189.

Menn, I., Junghans, C. and Reise, K., 2003. Buried alive: Effects of beach nourishment on the infauna of an erosive shore in the North Sea. Senckenbergiana marit. 32: 125-145.

MEPC 48/7/2, 2002. Identification and Protection of Special Areas and Particularly Sensitive Sea Areas. Designation of the Wadden Sea as a Particularly Sensitive Sea Area. Submitted by Denmark, Germany and the Netherlands: 13 pp. and 3 Annexes.

Merckelbach, L.M. and Eysink, W.D., 2001. Trendanalyse zwevend stof in Eems estuarium in relatie tot aanslibbing haven Delfzijl. WL | Delft Hydraulics. Project Z3210. Commissioned by National Institute for Coastal and Marine Management/RIKZ, Den Haag.

Metzing,D. and Gerlach,G., 2003. Vegetationsökologie. In: Fleming, B.W. (Ed.). Untersuchung der ökologischen Entwicklung einer Aussendeichskleipütte als Ergänzung der quantitativen Beweissicherung des Wiederverlandungsprozesses. Abschlussbericht. Senckenberg am Meer. Bericht 03-1: 24-48.

Meyn, L., 1859. Wurmsandstein. – Mitteilungen des Vereins nördlich der Elbe. In: Jahresbücher für die Landeskunde der Herzogtümer Schleswig, Holstein und Lauenburg, Band II, 102-104.

Michaelis, H., Ohba, T. and Tüxen, R., 1971. Die Zostera-Gesellschaften der niedersächsischen Watten. Jber. Forsch.-Stelle Insel- u. Küstenschutz Norderney 21: 87-100.

Michaelis, H., Obert, B., Schultenkötter, I. and Böcker, L., 1995. Die Miesmuschelbestände der Niedersächsischen Watten (1989-1991). Ber. Forschungsstelle Küste Norderney 40: 55-71.

Millat, G. and Herlyn, M., 1999. Documentation of intertidal mussel bed (*Mytilus edulis*) sites at the coast of Lower Saxony. Senckenbergiana maritima 29: 83 – 93.

Mittelplate Konsortium, 2004. History of Mittelplate oil production. Brochure, 08/2004.

ML, 1973. Generalplan Küstenschutz Niedersachsen. Niedersächsischer Minister für Landwirtschaft, Ernährung und Forsten (ML), Hannover.

MLR, 2001. Generalplan Küstenschutz: integriertes Küstenschutzmanagement in Schleswig-Holstein. Ministerium für ländliche Räume, Landesplanung, Landwirtschaft und Tourismus des Landes Schleswig-Holstein (MLR), Kiel, 76 pp.

Mock, K., F. Hofeditz, V. Knoke, 1998. Gänse und Touristen auf den Salzwiesen Eiderstedts. In NPA & UBA (Eds.). Umweltatlas Wattenmeer, Band I: Nordfriesisches und Dithmarscher Wattenmeer. Ulmer Verlag GmbH, 186-187.

Molen, J. van der, 2002. The influence of tides, wind and waves on the net sand transport in the North Sea. Cont. Shelf Res. 22: 2739-2762.

Molen, J. van der, and de Swart, H.E., 2001. Holocene tidal conditions and tide-induced sand transport in the southern North Sea. J. Geophys. Res. 106 (C5): 9339-9362.

Möller, A., 1996. Socio-economic monitoring. In: Marencic, H., Bakker, J., Farke, H., Gätje, C., de Jong, F., Kellermann, A., Laursen, K., Pedersen, T.F. and J. de Vlas, 1996. The Trilateral Monitoring and Assessment Program (TMAP). Expert Workshops 1995/96. Wadden Sea Ecosystem No. 6. Common Wadden Sea Secretariat and Trilateral Monitoring and Assessment Group, Wilhelmshaven, Germany, 66-70.

Moorsel, W.W.N.M. van, 1993. Monitoring kunstriffen Noordzee 1992. Bureau Waardenburg, Culemborg. Rapport 93.02.

Moser, M. and Brown, A., 2007. Trilateral Wadden Sea cooperation. External Evaluation Report. CWSS, Wilhelmshaven.

Mulder, J.P.M., 2000. Zandverliezen in het Nederlandse kustsysteem, advies voor dynamisch handhaven in de 21e eeuw. Rijksinstituut voor Kust en Zee/RIKZ, Den Haag. Rapport RIKZ-2000.36.

Mulder, S., 2000. Ecologie van de zandige kust. Het voorkomen van benthische macrofauna en meiofauna in relatie tot versteiling van de kust. Working document RIKZ/OS/200.617x.

Mulder, S. and Peperzak, L., 2003. Van de regen in de drup? Verkenning van ecologische effecten van klimaatverandering op Nederlandse zee- en kustecosystemen. Rijksinstituut voor Kust en Zee/RIKZ, Den Haag. Werkdocument RIKZ/0S/2003.604x.

Mulder,H.P.J., 2004. Dumping in the Ems estuary: an overview of effects and developments. National Institute for Coastal and Marine Management/RIKZ, Haren. Werkdocument RIKZ/AB/2004.610W, pp. 10.

Munch-Petersen, S and Kristensen, P.S., 2001. On the dynamics of the stocks of blue mussels (*Mytilus edulis* L.) in the Danish Wadden Sea. In: G. Burnell (Ed.), Coastal Shellfish – A Sustainable Resource. Hydrobiologia 465: 31-43.

Munch-Petersen, S. and Kristensen, P.S., 1987. Assessment of the stocks of mussels in the Danish Wadden Sea. ICES, Shellfish Committee, C.M. 1987/K:13, pp. 21.

Munksgaard, C., 1989. Investigations of the mussel stocks in the Danish Wadden Sea. Rept. to the Forest and Nature Agency. Inst. of Genetics and Ecol., Aarhus University. 39 pp. (In Danish).

Muñoz Cifuentes, J., 2004. Seabirds at risk? Effects of environmental chemicals on reproductive success and mass growth of seabirds breeding at the Wadden Sea in the mid 1990s. Wadden Sea Ecosystem No. 18: 27-51 Common Wadden Sea Secretariat, Trilateral Monitoring and Assessment Group, Wilhelmshaven.

Nacken, M. and Reise, K., 2000. Effects of herbivorous birds on intertidal seagrass beds in the northern Wadden Sea. Helgol. Mar. Res. 54: 87-94.

Nehls, G., 2001. Food selection by Eiders – Why quality matters. Wadden Sea Newsletter 2001-1, 39-41.

Nehls, G., 2003. Miesmuschelmonitoring im Nationalpark Schleswig-Holsteinisches Wattenmeer 1998 – 2003. Gutachten im Auftrag des Landesamtes für den Nationalpark Schleswig-Holsteinisches Wattenmeer. Hockensbüll.

Nehls, G. and Ruth, M., 2004. Miesmuschelmonitoring und Miesmuschelmanagement im Nationalpark Schleswig-Holsteinisches Wattenmeer. Berichtszeitraum 1997-2002. Gutachten im Auftrag des Landesamtes für den Nationalpark Schleswig-Holsteinisches Wattenmeer und des Amtes für Ländliche Räume Kiel. Hockensbüll und Kiel.

Nehls, G., S. Diederich, D. Thieltges & M. Strasser 2005: Perishing blue mussels and invading aliens – What are the reasons for ecological turnover in the Wadden Sea ? Wadden Sea Newsletter 2005-1: 17-20

Nehls, G., S. Diederich, D. Thieltges & M. Strasser 2006: Wadden Sea mussel beds invaded by oysters and slipper limpets: competition or climate control? Helgol Mar Res 2006 60: 135–143,

Nehls, G. & H. Büttger 2006: Miesmuschelmonitoring im Nationalpark Schleswig-Holsteinisches Wattenmeer 1998 – 2005. Husum.

Nehls, G. & H. Büttger 2007: Miesmuschelmonitoring im Nationalpark Schleswig-Holsteinisches Wattenmeer 2006. in prep., Husum.

Nehls, G. & H. Büttger, 2007. Spread of the Pacific Oyster Crassostrea gigas in the Wadden Sea. Causes and consequences of a successful invasion. Report, Common Wadden Sea Secretariat, Wilhelmshaven.

Nehring, S. and Leuchs, H., 1999. The BfG-Monitoring in the German North Sea estuaries: macrozoobenthos. Senckenbergiana marit. 29, Suppl., 107-111.

Nehring, S. and Leuchs, H., 1999. Neozoa (Makrobenthos) an der deutschen Nordseeküste – Eine Übersicht. Ber. Bundesanstalt für Gewässerkunde, Nr. 1200, pp. 131.

Nehring, S. and Klingenstein, F., 2005. Alien species in the Wadden Sea - A challenge to act. Wadden Sea Newsletter 2005.

Nehring, S., 2006. NOBANIS – Invasive Alien Species Fact Sheet – *Crassostrea gigas*. – From: Online Database of the North European and Baltic Network on Invasive Alien Species - NOBANIS www.nobanis.org, Date of access 15.3.2007.

Neudecker T., Fischer, J. and Damm, U., 1998. Influence of tidal currents on fishing performance in the Wadden Sea. ICES C.M. 1998/BB:6 (Theme Session (BB) on Fisheries Assessment Methods), pp. 11.

Neudecker, T., 1999. Die Entwicklung des Aufwandes in der deutschen Garnelenfischerei. Inf. Fischwirtsch. Fischereiforschung 46 (4), 9–13.

Neudecker, T., Damm, U. and Purps, M., 1999. Langzeitreihen - Fischbeifang aus der Garnelenfischerei. Abschlußbericht, Umweltbundesamt, UFOPLAN-Nr. 294 25 271 (226 Seiten, 22 Tabellen, 246 Abbildungen und 28 Literaturangaben). Unpublished report.

Neudecker, T., 2001. Der Demersal Young Fish Survey (DYFS) in Schleswig-Holstein – Entwicklung und derzeitiger Stand. In: Landesamt für den Nationalpark Schleswig-

Holsteinisches Wattenmeer (Hrsg.), 2001. Wattenmeermonitoring 2000. - Schriftenreihe des Nationalparks Schleswig-Holsteinisches Wattenmeer, Sonderheft, 24-30.

Neudecker T. and Damm, U., 2004. Recognition of a third callionymid species, *Callionymus reticulatus* Valenciennes 1837 (reticulated dragonet), in the south-eastern North Sea. J. Appl. Ichthyol., 20(3), 204-210.

Neuhaus, R. and Petersen, J., 1999. Dunes. In: Jong, F. de, Bakker, J., Van Berkel, C., Dankers, N., Dahl, K., Gätje, C., Marencic, H. and Potel, P. (Eds.): Wadden Sea Quality Status Report. Wadden Sea Ecosystem No. 9. Common Wadden Sea Secretariat, Wilhelmshaven, p. 53-56.

Nies, H., Gaul, H., Oestereich. F., Albrecht, H., Schmolke, S., Theobald, N., Becker, G., Schulz ,A., Frohse, A., Dick, S., Müller-Navarra, S. and Herklotz, K., 2003. Die Auswirkungen des Elbehochwassers vom August 2002 auf die Deutsche Bucht. Abschlussbericht Juni 2003. Berichte des Bundesamtes für Seeschifffahrt und Hydrographie Nr. 32/2003, pp. 81.

NLWK, 2003. Vorlandmanagementplan für den Bereich der Deichacht Norden. Niedersächsischer Landesbetrieb für Wasserwirtschaft und Küstenschutz - Betriebsstelle Norden (NLWK).

NLWK/BRWE, 2001. Kompensationsmaßnahme EUROPIPE I und II. Renaturierung des Langeooger Sommerpolders, Erläuterungsbericht.

Noordhuis, R. and Spaans, A.L., 1992. Interspecific competition for food between Herring Gull *Larus argentatus* and Lesser Black-backed Gull *L. fuscus* in the Dutch Wadden Sea area. Ardea 80, 115-132.

Nordheim, H. von, Norden Anderson, O. and Thiessen, J. (Eds.), 1996. Red List of Biotopes, Flora and Fauna of the Trilateral Wadden Sea Area, 1995. Helgoländer Meeresunters. 50, (Suppl.).

Nugteren, J. van, 1997. Dark-bellied Brent Goose *Branta bernicla bernicla* - Flyway management plan. (Working document). prepared for the Dutch Ministry of Agriculture, Nature Management and Fisheries, IKC-Natuurbeheer, Wageningen, NL, pp. 159.

OAG - Ornithologische Arbeitsgemeinschaft für Schleswig-Holstein und Hamburg (Eds.), 2001. Wiesenvögel in Nordwestdeutschland. Corax 18, Sonderheft 2, 1-148.

Olsen, J.L., Stam, W.T., Coyer, J.A., Reusch T.B.H., Billingham, M., Boström C., Calvert, E., Christie, H., Granger, S., Lumière, R. la, Milchakova, N., Oudot-le Secq, M.-P., Procaccini, G., Sanjabi, B., Serrão, E., Veldsink, J., Iddicombe, S. and Wyllie-Echeverria, S., 2004. North Atlantic phylogeography and large-scale population differentiation of the seagrass Zostera marina L. Mol. Ecol. 13:1923-1941.

Oltmanns, B. 2003. Von der Hellerweide zur Salzwiese: Veränderungen der Brutvogelgemeinschaft in der Leybucht durch die Nutzungsaufgabe. Vogelkdl. Ber. Niedersachs. 35, 157-166.

Oost, A.P., Ens, B.J., Brinkman, A.G., Dijkema, K.S., Eysink, W.D., Beukema, J.J., Gussinklo, H.J., Verboom, B.M.J., Verburgh, J.J., 1998. Integrale Bodemdalingsstudie Waddenzee. Nederlandse Aardolie Maatschappij B.V., Assen, 372 pp.

Oost, A.P. and Bokhorst, M., 2002. Effecten van spuilocaties op hydraulica, morfologie en ecologie: effecten van alternatieve spuilocaties langs de Afsluitdijk op hydraulica, morfologie en ecologie van Waddenzee en IJsselmeer) Rijksinstituut voor Kust en Zee / RIKZ. Rapport RIKZ/2002.056, RIKZ, Den Haag.

Oosterhuis, R. and Dijk, K. van, 2002. Effect of food shortage on the reproductive output of Common Eiders *Somateria mollissima* breeding at Griend (Wadden Sea). Atlantic Seabirds 4, 29-38.

Opaschowski, 2004. 20. Deutsche Tourismusanalyse, Freizeit aktuell, 178 pp.

OSPAR Commission 2000. Quality Status Report 2000. Region II – Greater North Sea. OSPAR Commission, London, 136 pp.

OSPAR, 2003. OSPAR integrated report 2003 on the Eutrophication Status of the OSPAR Maritime Area based upon the first application of the Comprehensive Procedure. OSPAR Commission 2003, pp. 59.

Pachur, H.-J., Ricking, M., Sommerfeldt, B., Varlemann, R., Bakker, J.F. and Smedes, F., 1995. Geoaccumulation of environmental contaminants in sediments of the lower Ems river in the framework of the European project 'Chemical Time Bombs'. Report no. 107 01 016/17 of the Federal Environmental Agency (UBA), Berlin.

Pastoors, M., Bolle, L., Groeneveld, K., Groot, P., Leeuwen, P. van, Piet, G., Rijnsdorp, A., and Rink, G., 2000. Evaluatie van de scholbox. RIVO rapport C002/00. Rijksinstituut voor Visserij Onderzoek, IJmuiden.

Pawlik, J.R., 1992. Chemical ecology of the settlement of benthic marine invertebrates. Oceanogr. Mar. Biol. Ann. Rev. 30: 273-335.

Pedersen, I.K., Clausager, I. and Christensen, T.K., 2003. Bird numbers and distribution in the Horns Rev offshore wind farm area. Report for Elsam Eigineering A/S by National Environmental Institute, Rønde.

Peeters, J.C.H., Vries, I. de and Haas, H., 1999. Eutrofiering en productiviteit in de Noordzee. Rijksinstituut voor Kust en Zee/RIKZ, Den Haag. Rapport RIKZ-99.008,

Pejrup, M., Jensen, A., Zyserman, J., Rønberg, J.K., Birklund, J., Rasmussen, E.K. and Bartholdy, J., 1993. Miljømæssig vuredeing af uddybning af Grådyb. Konsekvensvurdering.- Dansk Hydraulisk Institut, Vandkvalitetsinstitutet og Geografisk Institut, Hørsholm.

Peperzak, L., 2003. Climate change and harmful algal blooms in the North Sea. Acta Oecol. 24: 139-144.

Peppler-Liesbach, C. and Petersen, J., 2001. Calluno-Ulicetea (G3), Teil 1: Nardetalia. In: Dierschke, H. (Hrsg.): Synopsis der Pflanzengesellschaften Deutschlands, 8, pp.117.

Peters, M., 1996. Vergleichende Vegetationskartierung der Insel Borkum und beispielhafte Erfassung der Veränderung von Landschaft und Vegetation einer Nordseeinsel. Diss. Botanicae 257, Berlin, Stuttgart, pp. 227.

Petersen, J., 2000. Die Dünentalvegetation der Wattenmeer-Inseln in der südlichen Nordsee. Eine pflanzensoziologische und ökologische Vergleichsuntersuchung unter Berücksichtigung von Nutzung und Naturschutz. Husum Verlag, Husum.

Petersen, J., 2000a: Dune slack vegetation of the Wadden Sea islands - ecology, phytosociology, nature conservation and management. Wadden Sea Newsletter 2000-1, 12-13, Common Wadden Sea Secretariat, Wilhelmshaven.

Petersen, J., 2001. Die Vegetation der Wattenmeer-Inseln im raumzeitlichen Wandel. Ein Beispiel für den Einsatz moderner vegetationsanalytischer Methoden. Ber. d. Reinh.-Tüxen-Ges. 13, 139-155.

Petersen, J. and Westhoff, V., 2001. Duinvalleien van Terschelling - de vegetatie in verleden en heden. De Levende Natuur 102-03: 114-117.

Petersen, J. and Marencic, H., 2001. Monitoring of Beaches and Dunes of the Wadden Sea islands. Wadden Sea Newsletter 2001-3, 16-19, Common Wadden Sea Secretariat, Wilhelmshaven.

Petersen, J. and Pott, R., 2005. Ostfriesische Inseln. Landschaft und Vegetation im Wandel. Schriften zur Heimatpflege, Band 15, Schlütersche Verlagsgesellschaft Hannover, pp. 160.

Petersen, J., Pott, R. and Richter, O., 2001. Dünentäler – Ein gefährdeter Lebensraum im Interessenkonflikt zwischen Naturschutz und Grundwasserbewirtschaftung. Zbl. Geol. Paläont. Teil I, 1/2, 1–18.

Petersen, J. and Sütering, U., 2003. Neue Methoden zur Erfassung und Bewertung grundwasserabhängiger Biotope. Wasser and Boden 7/8, 58-64, Berlin.

Petersen, J., Pott, R., Janiesch, P. and Wolff, J., 2003. Umweltverträgliche Grundwasserbewirtschaftung in hydrogeologisch und ökologisch sensiblen Bereichen der Nordseeküste. Husum Verlag, Husum.

Petersen, J., 2003. Vegetationskundliche Erfassung nach dem Verschluss von Gräben im Salzwiesenbereich auf Norderney. Anlage von Dauerflächen, Vegetationskartierung, Vegetationsvergleich und Bewertung. Unveröffentlichtes Gutachten im Auftrag der Nationalparkverwaltung Nds. Wattenmeer.

Petersen, J., 2004. Dünentalvegetation unter dem Einfluss des Menschen. Naturschutz-Management und Nutzung auf den niederländischen, deutschen und dänischen Wattenmeer-Inseln. Stratiotes 28/29, 41-44.

Petersen, J. and Lammerts, E.J., 2005. Dunes. In: Essink, K., Dettmann, C., Farke, H., Laursen, K., Lüerßen, G., Marencic, H. and Wiersinga, W. (eds.). Wadden Sea Quality Status Report 2004. Wadden Sea Ecosystem No. 19. Common Wadden Sea Secretariat, Trilateral Monitoring and Assessment Group, Wilhelmshaven, Germany.

Philippart, C.J.M., 1994. Interactions between Arenicola marina and Zostera noltii on a tidal flat in the Wadden Sea. Mar. Ecol. Prog. Ser. 111: 251-257.

Philippart, C. J. M., Cadée, G. C., van Raaphorst, W. and Riegman, W., 2000. Long-term phytoplankton-nutrient interactions in a shallow coastal sea: algal community structure, nutrient budgets, and denitrification potential. Limnol. Oceanogr. 45: 131-144.

Philippart, C.J.M., van Aken, H.M., Beukema, J.J., Bos, O.G., Cadée, G.C., Dekker, R., 2003. Climate-related changes in recruitment of the bivalve *Macoma balthica*. Limnol. Oceanogr. 48: 2171-2185.

Piersma T., A. Koolhaas, 1997. Shorebirds, shellfish(eries) and sediments around Griend, western Wadden Sea, 1988-1996. Rapport 1997-7. NIOZ, Texel.

Piersma, T., Koolhaas, A., Dekinga, A., Beukema, J.J., Dekker, R., Essink, K., 2001. Long-term indirect effects of mechanical cockle-dredging on intertidal bivalve stocks in the Wadden Sea. J. Appl. Ecol. 38: 976-990.

Piersma, T., 2007. Why do molluscivorous shorebirds have such a hard time in the Wadden Sea right now. In: Reineking, B. and Südbeck, P. (Eds.). Seriously declining trends in migratory waterbirds: Causes-Concerns-Consequences. Proceedings of the International Workshop on 31 August 2006 in Wilhelmshaven, Germany. Wadden Sea Ecosystems No. 23. Common Wadden Sea Secretariat, Wadden Sea National Park of Lower Saxony, Institute of Avian Research, Joint Monitoring Group of Migratory Birds in the Wadden Sea, Wilhelmshaven, Germany, p. 53 – 64.

Planco, 2003. Inventory and Evaluation of Socio-Economic and Socio-Cultural Data in the German Wadden Sea Region. Wadden Sea Forum Report No. 3, 116 pp.

Policy Assessment Report, 2001. In: Esbjerg Declaration 2001. Ministerial Declaration of the Ninth Trilateral Governmental Conference on the Protection of the Wadden Sea. Esbjerg, 2001. Common Wadden Sea Secretariat, Wilhelmshaven, pp. 55 – 109.

Postma, H., 1954. Hydrography of the Dutch Wadden Sea. Archives néerlandaises de Zoologie, 10: 405-511.

Postma, H., 1966. The cycle of nitrogen in the Wadden Sea and adjacent areas. Neth. J. Sea Res. 3: 186-221.

Potel, P., Südbeck, P. and Hälterlein, B., 1998. Wie kommen wir zu einem verbesserten Schutz der Strandvögel im Wattenmeer. Seevögel 19, Sonderheft, 75-80.

Pott, R., 1995. Die Pflanzengesellschaften Deutschlands. Ulmer Verlag, Stuttgart.

Pott, R., 1995. Farbatlas Nordseeküste und Nordseeinseln. Ausgewählte Beispiele aus der südlichen Nordsee aus geobotanischer Sicht. Ulmer Verlag, Stuttgart.

PROGNOS, 2004. Sector-specific analysis and perspectives for the Wadden Sea Region. Part two: sector-specific analysis. Wadden Sea Forum Report No. 8, November 2004, 197 pp.

Raaphorst, W. van, de Jonge, V.N., Dijkhuizen, D. and Frederiks, B., 2000. Natural background concentrations of phosphorus and nitrogen in the Dutch Wadden Sea. Report RIKZ/2000.013, pp. 53.

Rahmel, J., Schranz, H., Tyedmers, S. and Heiber, W., 1999. Untersuchungen zur Erfassung schutzwürdiger Lebensräume im Sublitoral der niedersächsischen Küste unter Zuhilfenahme von Sonartechniken. Dienstber. Forschungsstelle Küste 8/1999, unpubl. report, pp. 44.

Rappoldt, C., Ens, B.J., Dijkman, E. and Bult, T. 2003. Voedselreservering voor Scholeksters in de Nederlandse Waddenzee. EVAII deelrapport B1. Alterra, Wageningen, Alterra rapport 882, 1-152.

Rasmussen, L-M., Fleet, D.M., Hälterlein, B., Koks, B.J., Potel, P. and Südbeck, P., 2000. Breeding birds in the Wadden Sea in 1996. Wadden Sea Ecosystem No. 10. Common Wadden Sea Secretariat, Wilhelmshaven.

Rasmussen, L-M., Norden-Andersen, O.G., Frikke J., Laursen K., Salvig J., Fleet, D.M., Hälterlein B., Heckenroth, H., Merck, T., Rösner, H-U., Südbeck, P., Wolff, W.J. and Thissen, J. 1996. Red Lists of birds in the Wadden Sea. In: Biotopes, Flora and Fauna of the Trilateral Wadden Sea Area. Helgoländer Meeresunters. 50, Suppl., 113-128.

Rasmussen, L-M., and Laursen, K. 2000. Fugle i Tøndermarsken – bestandsudvikling og landbrug. - TEMA-rapport fra DMU, Danmarks Miljøundersøgelser, Miljø- og Energiministeriet.

Reijnders, P.J.H., Dijk, J. van. and Kuiper, D., 1995. Recolonization of the Dutch Wadden Sea by the grey seal *Halichoerus grypus*. Biol. Conserv. 71, 231–235.

Reijnders, P.J.H., 1996. Development of grey and harbour seal populations in the international Wadden Sea: reorientation on management and related research. Wadden Sea Newsletter 1996(2), 12–16.

Reijnders, P.J.H., Ries, E.H., Tougaard, S., Nørgaard, N., Heidemann, G., Schwarz, J., Vareschi, E. and Traut, I.M., 1997. Population development of harbour seals *Phoca vitulina* in the Wadden Sea after the 1988 virus epizootic. J. Sea Res. 38, 161-168.

Reijnders, P.J.H. and Brasseur, S.M.J.M., 2003. Veränderungen in Vorkommen und Status der Bestände von Seehunden und Kegelrobben in der Nordsee – Mit Anmerkungen zum Robbensterben 2002. In: J. Lozán, E. Rachor, K. Reise, J. Sündermann and H. von Westernhagen (Hrsg.), Warnsignale aus der Nordsee: Neue Folge. Vom Wattenmeer bis zur offenen See. Wissenschaftliche Auswertungen, Hamburg (ISSN 3-00-010166-7), in Kooperation mit GEO, 330-339.

Reijnders, P.J.H. and Brasseur, S.M.J.M., 2003. Vreemde snuiten aan onze kust. Zoogdier 14, 5-10.

Reijnders, P.J.H., Abt, K.F., Brasseur, S.M.J.M., Tougaard, S., Siebert, U. and Vareschi, E., 2003a. Sense and sensibility in evaluating aerial counts of harbour seals in the Wadden Sea. Wadden Sea Newsletter 28, 9-12.

Reijnders, P.J.H., Brasseur, S.M.J.M., Abt, K.F., Siebert, U., Stede. M. and Tougaard, S., 2003b. The harbour seal population in the Wadden Sea as revealed by the aerial surveys in 2003. Wadden Sea Newsletter 29, 11-12.

Reijnders, P.J.H., Brasseur, S.M.J.M. and Brinkman, A.G., 2003. The phocine distemper virus outbreak of 2002 amongst harbour seals in the North Sea and Baltic Sea: spatial and temporal development, and predicted population consequences. In: Management of North

Sea harbour and grey seal populations. Proceedings of the International Symposium at EcoMare, Texel, The Netherlands, November 29-30, 2002. Wadden Sea Ecosystem No. 17, Wadden Sea Secretariat, Wilhelmshaven, Germany. pp.19-25.

Reijngoud, T.T., 2001. Eindrapport Vervolgonderzoek Schelpenwinning. Rijkswaterstaat, Directie Noord-Nederland, Leeuwarden. Rapport nr: DNN 826/2001.

Reineking, B., 1997. Verölte Seevögel im Spülsaum - Hinweise auf Ölverschmutzung durch den Seeverkehr. Deutsche Hydrogr. Zeitschr., Aktuelle Probleme der Meeresumwelt, Supplement 7, 113-123.

Reineking, B., 2002. The Wadden Sea designated as a PSSA. Wadden Sea Newsletter 2002 - No.2, 10-12.

Reineking, B., and Fleet, D.M., 2002. Einfluss von Öl auf Seevögel und Meeressäuger. In: Lozán, J.L., E. Rachor, K. Reise, J. Sündermann, H. von Westernhagen (Eds.). Warnsignale aus Nordsee & Wattenmeer. Eine aktuelle Umweltbilanz. Wissenschaftliche Auswertungen, Hamburg, 235-237.

Reineking, B., and Vauk, G., 1982. Seevögel - Opfer der Ölpest. Jordsandbuch Nr 2., Ed. Verein Jordsand zum Schutz der Seevögel e.V. Otterndorf, pp. 143.

Reineking, B. and Südbeck, P. (Eds.), 2007. Seriously declining trends in migratory waterbirds: Causes-Concerns-Consequences. Proceedings of the International Workshop on 31 August 2006 in Wilhelmshaven, Germany. Wadden Sea Ecosystems No. 23. Common Wadden Sea Secretariat, Wadden Sea National Park of Lower Saxony, Institute of Avian Research, Joint Monitoring Group of Migratory Birds in the Wadden Sea, Wilhelmshaven, Germany.

Reise, K., 1982. Long-term changes in the macrobenthic invertebrate fauna of the Wadden Sea: are polychaetes about to taker over? Neth. J. Sea Res. 16: 29-36.

Reise, K., 1983. Sewage, green algal mats anchored by lugworms and the effects on Turbellaria and small Polychaeta. Helgoländer Meeresunters. 36, 151-162.

Reise, K., Herre, E. and Sturm, M., 1989. Historical changes in the benthos of the Wadden Sea around the island of Sylt in the North Sea. Helgoländer Meeresunters 43: 417-433.

Reise, K., 1992. The Wadden Sea as a pristine nature reserve. Neth. Inst. Publ. Ser No. 20: 49-53.

Reise, K. and Siebert, I., 1994. Mass occurrence of green algae in the German Wadden Sea. DHZ Suppl. 1: 171-188.

Reise, K., 1994. The Wadden Sea: Museum or cradle for nature? Wadden Sea Newsletter 1994-1: 5-8.

Reise, K. and Gätje, C., 1997. The List tidal basin: a reference area for scientific research in the northern Wadden Sea. Helgol Meeresunters 51: 249-251.

Reise, K., 1998. Pacific oysters invade mussel beds in the European Wadden Sea. Senckenbergiana marit. 28, 167-175.

Reise, K., 2001. Algen und Seegras: grüne Matten und Wiesen im Watt. In: Landesamt für den Nationalpark Schleswig-Holsteinisches Wattenmeer (Ed.). Wattenmeermonitoring 2000. Schriftenreihe des Nationalparks Schleswig-Holsteinisches Wattenmeer: 55-56.

Reise, K., Gollasch, S. and Wolff, W.J., 2002. Introduced marine species of the North Sea coasts. In: Leppäkoski, E., Gollasch, S., Olenin, S. (Eds), Invasive aquatic species of Europe. Distribution, impacts and management. Kluwer Academic Publ, Dordrecht, 260-266.

Reise, K. and Lackschewitz, 2003. Combating habitat loss at eroding Wadden Sea shores by sand replenishment. In: Wolff, W.J., Essink, K., Kellermann, A. and Leeuwe, M.A., (Eds.), Challenges to the Wadden Sea Area. Proceedings of the 10th International Scientific

Wadden Sea Symposium, Groningen 31.10.-03.11.2000, Ministry of Agriculture, Nature Management and Fisheries and University of Groningen, 197-206.

Reise, K., 2003. Grüner Wechsel im Wattenmeer: weniger Seegraswiesen und das Aufkommen der Grünalgenmatten. In: Lozán, J.L., Rachor, E., Reise, K., Sündermann, J., Westernhagen, H. von, (Eds.). Warnsignale aus Nordsee und Wattenmeer – eine aktuelle Umweltbilanz. Wiss Auswertungen, Hamburg, 196-200.

Reise, K., 2003. Metapopulation structure in the lagoon cockle *Cerastoderma lamarcki* in the northern Wadden Sea. Helgol. Mar. Res. 56: 252-258.

Reise, K., 2005. Coast of change: Habitat loss and transformations in the Wadden Sea. Helgol. Mar. Res. 59 (1), p. 9 -21.

Remane, A., 1933. Verteilung und organisation der benthonischen Mikrofauna der Kieler Bucht. Wiss Meeresunters, Abt. Kiel, NF 21: 161-221.

Remmers, I., 2003. Salzwiesen im Nationalpark "Niedersächsisches Wattenmeer": Ziele und Wege für eine nachhaltigen Arten- und Lebensraumschutz. Vogelkdl. Ber. Niedersachs. 35, 109-114.

Remmert, H., 1987. Sukzessionen im Klimax-Stadium. Verh. Ges. Ökol. XVI: 27-34.

Reneerkens, J., Piersma, T. and Spaans, B., 2005. De Waddenzee als kruispunt van vogeltrekwegen. Literatuurstudie naar de kansen en bedreigingen van wadvogels in internationaal perspectief. NIOZ-report 2005-4, Texel.

Rennwald, E. (Ed.), 2000. Verzeichnis und Rote Liste der Pflanzengesellschaften Deutschlands. Schriftenreihe für Vegetationskunde: 35, Bundesamt für Naturschutz, Bonn - Bad Godesberg, pp. 820.

Reusch, T.B.H., 2002. Microsatellites reveal high population connectivity in eelgrass (*Zostera marina*) in two contrasting coastal areas. Limnol. Oceanogr. 47: 78-85.

Riesen, W. and Reise, K., 1982. Macrobenthos of the subtidal Wadden Sea: revisited after 55 years. Helgoländer Meeresunters. 35: 409-423.

Rijnsdorp, A.D., Stralen, M. van and Veer, H.W van der, 1985. Selective tidal transport of North Sea plaice larvae *Pleuronectes platessa* in coastal nursery areas. Trans. Am. Fish. Soc. 114, 461-470.

RIKZ (Ed.), 1998, 1999, 2000, 2001, 2002, 2003. Jaarboek Waddenzee. Kennis gebundeld door de overheden. Leeuwarden: Werkgroep kennisbeheer Waddenzee.

Ringot, J. L., 1997. Biotop- und Nutzungstypenkartierung terrestrischer Bereiche des Nationalparks Nds. Wattenmeer 1997. Nationalparkverwaltung Niedersächsisches Wattenmeer, Wilhelmshaven.

RIS, 2004. Tourismus Fokus Weser-Ems. Regionale Innovationsstrategie Weser-Ems, Oldenburg, www.ris-weser-ems.de.

Roomen, M. van, E. van Winden, K. Koffijberg, R. Kleefstra, G. Ottens, SOVON Ganzen- en Zwanenwerkgroep, 2003. Watervogels in Nederland in 2001/2002. (In Dutch with English Summary). SOVON-monitoringrapport 2003/04, SOVON Vogelonderzoek Nederlands, Beek-Ubbergen, NL, pp. 211.

Roomen, M. van, Turnhout, C. van, Winden, E. van, Koks, B., Goedhart, P., Leopold, M. and Smit, C.J., 2005. Trends in benthivorous waterbirds in the Dutch Wadden Sea 1975-2002: large differences between shellfish-eaters and worm-eaters. Limosa 78, 21-38.

Rösner, H.-U., 1993. The joint monitoring project for migratory birds in the Wadden Sea. Report to the Trilateral Cooperation on the Protection of the Wadden Sea. CWSS, Wilhelmshaven, pp. 16.

Rösner H.-U., 2003. Jan van de Kam Preisträger bei den Ringelganstagen 2003. In: Wattenmeer Inter-national, Husum. 21/2-3: 23.

Rüdel, H., Lepper, P., Steinhanses, J. and Schröter-Kermani, C., 2003. Retrospective monitoring of organotin compounds in marine biota from 1985 to 1999: Results from the German Environmental Specimen Bank. Environ. Sci. Technol. 37: 1731-1738.

Ruesink, J. L., H. S. Lenihan, A. C. Trimble, K. W. Heiman, F. Micheli, J. E. Byers & M. C. Kay 2005. Introduction of non-native oysters: ecosystem effects and restoration implication. Ann. Rev. Ecol. Evol. Syst. 36: 643-689.

Saier, B., 2000. Age-dependent zonation of the periwinkle *Littorina littorea* (L.) in the Wadden Sea. Helgol. Mar. Res. 54, 224-229.

Saier, B., 2001. Direct and indirect effects of seastars *Asterias rubens* on mussel beds (Mytilus edulis) in the Wadden Sea. J. Sea Res. 46, 29-42.

Saier, B., 2002. Subtidal and intertidal mussel beds (Mytilus edulis L.) in the Wadden Sea: diversity differences of associated epifauna. Helgol. Mar. Res. 56, 44-50.

Schanz, A., Polte, P. and Asmus, H., 2002. Cascading effects of hydrodynamics on an epiphyte-grazer system in intertidal seagrass beds of the Wadden Sea. Mar. Biol. 141: 287-297.

Schanz, A. and Asmus, H., 2003. Impact of hydrodynamics on development and morphology of intertidal seagrasses in the Wadden Sea. Mar. Ecol. Prog. Ser. 261:123-134.

Scheidat, M., Kock, K-H. and Siebert, U. 2003. Summer distribution of Harbour Porpoises *Phocoena phocoena* in German waters. Paper presented to 10th AC ASCOBANS meeting, 9-11 April 2003.

Scheiffarth, G., D. Frank, 2005. What can we learn from current monitoring programs? A case study on shellfish eating birds in the European Wadden Sea. In: Blew, J. and P. Südbeck (Eds.). Migratory waterbirds in the Wadden Sea 1980-2000. Wadden Sea Ecosystem No. 20, Common Wadden Sea Secretariat, Trilateral Monitoring and Assessemnt Group, Joint Monitoring Group of Migratory Birds in the Wadden Sea, Wilhelmshaven, Germany.

Scheiffarth, G. and Frank, D., 2006. Eiderentensterben im niedersächsischen Wattenmeer: der Einfluss der Nahrungsqualität auf Bestand und Kondition der Eiderente. Abschlussbericht des Projektes 16/00 der Niedersächsischen Wattenmeerstiftung, Institut für Vogelforschung ”Vogelwarte Helgoland“, Wilhelmshaven.

Scheiffarth, G., Ens, B. and Schmidt, A., 2007. What will happen to birds when Pacific Oysters take over the mussel beds in the Wadden Sea? Wadden Sea Newsletter No. 33, 2007-1.

Schmidt, H., 2001. Die Entwicklung der Sturmhäufigkeit in der Deutschen Bucht zwischen 1879 und 2000. Klimastatusbericht 2001, Deutscher Wetterdienst, Offenbach/Main, 199-205.

Schories, D. and Albrecht, A. 1995. Sargassum muticum der japanische Beerentang im deutschen Wattenmeer. Natur und Museum, Frankfurt 125, 92-98.

Schrader, S., 2003. Zehn Jahre später - Brutvogelbestände in unterschiedlich beweideten Salzwiesen der schleswig-holsteinischen Festlandsküste. Vogelkdl. Ber. Niedersachs. 35, 167-172.

Schrap, M.S., Pijnenburg, A.M.C.M. and Geerdink, R.B., 2004. Perfluorinated compounds in Dutch surface waters: a screening of PFOS and PFOA in 2003. RIZA report 2004.025; RIKZ report 2004.037 (in Dutch with English summary). ISBN 903695682, December 2004.

Schröder, H.K., Kiehl, K. and Stock, M., 2002. Directional and non-directional vegetation changes in a temperate salt marsh in relation to biotic and abiotic factors. Applied Vegetation Science 5: 33-44.

Schuchardt, B., Schirmer, M., Janssen, G., Nehring, S. and Leuchs, H., 1999. Estuaries and Brackisch Waters. In: Jong, F. de, Bakker, J., van Berkel, C., Dahl, K., Dankers, N., Gatje, C. Marencic, H. and Potel, P. (Eds) Wadden Sea Quality Status Report 1999. Wadden Sea Ecosystem No. 9. Common Wadden Sea Secretariat, Trilateral Monitoring and Assessment Group, Quality Status Report Group. Wilhelmshaven, Germany, pp. 175-186.

Schuchardt, B. and Schirmer, M., (Eds.) 2005. Klimawandel und Küste. Die Zukunft der Unterweserregion. Springer Verlag Berlin Heidelberg. Pp. 341.

Schulz, R. 1998. Seeregenpfeifer *Charadrius alexandrinus* im Wattenmeer. Zwischen Überflutung und Prädation. Seevögel 19, Sonderheft, 71-74.

Seal Management Plan, 1992, Conservation and Management Plan for the Wadden Sea Seal Population, 1991-1995 (English version), In: Sixth Trilateral Governmental Wadden Sea Conference, Esbjerg, November 13,1991. Common Wadden Sea Secretariat, 101-117.

Seal Management Plan, 1996, Conservation and Management Plan for the Wadden Sea Seal Population, 1996-2000, including Additional Measures for the Protection of the Grey Seal (Adopted by Senior Officials, March 1996). Common Wadden Sea Secretariat March 1996. In: Wadden Sea Newsletter 1996-No.2, 41-54.

Seal Management Plan, 2002, Conservation and Management Plan for the Wadden Sea Seal Population, 2001-2006, including Additional Measures for the Protection of the Grey Seal in the Wadden Sea. In: Ministerial Declaration of the 9th Trilateral Governmental Conference on the Protection of the Wadden Sea, Esbjerg, October 31, 2001, Annex 1 (English version). Common Wadden Sea Secretariat, Wilhelmshaven, 25-37.

Short, A.D. and Wright, L.D., 1983. Physical variability of sandy beaches. In: McLachlan, A. and Erasmus, T. (Eds.). Sandy beaches as ecosystems, 133-144. W. Junk, The Hague.

Siebert, U., 2003. Monitoring the health status of harbour seals: pathological investigations before and during the PDV-virus outbreak. Proceedings of the International Symposium at EcoMare, Texel, The Netherlands, November 29-30, 2002. Wadden Sea Ecosystem No. 17, Wadden Sea Secretariat, Wilhelmshaven, Germany, 33-36.

Siebert, U., Gilles, A., Lucke, K, Ludwig, M., Benke, H., Kocke, K.H. and Scheidat M.. A decade of harbour porpoise occurrence in German waters – Analyses of aerial surveys, incidental sightings and strandings. J. Sea Res.

Sival, F.P. and Strijkstra-Kalk, M., 1999. Atmospheric deposition of acidifying and eutrophicating substances in dune slacks. Water, Air, and Soil Pollution 116: 461-477.

Skov, H., Durinck, J., Leopold, M.F. and Tasker, M.L., 1995. Important Bird Areas for Seabirds in the North Sea including the Channel and the Kattegat. Birdlife International, Cambridge, pp. 156.

Skov, H., Teilmann, J., Henriksen, O.D. and Carstensen, J., 2002. Investigations of harbour porpoises at the planned site for wind turbines at Horns Reef. Technical report to Techwise A/S. - Ornis Consult A/S, Copenhagen, pp 45.

Smaal, A.C., Stralen, M.R. van, Kersting, K. and Dankers, N., 2003. De gevolgen van gecontroleerde bevissing voor bedekking en omvang van litorale mosselzaadbanken- een test van de ‘Jan Louw’ hypothese en van de mogelijkheden voor natuurbouw. RIVO rapport. Yerseke, RIVO.

Smeenk, C., Garcia Hartmann, M., Addink, M.J. and Fichtel, L., 2004. High number of bycatch among beach cast harbour porpoises, *Phocoena phocoena*, in The Netherlands. Proceedings ECS Conference 2004, Kolmarden, Sweden. (Abstract).

Sonntag, R.P., Benke, H., Hiby, A.R., Lick, R. and Adelung, D., 1999. Identification of the first harbour porpoise *Phocoena phocoena* calving ground in the North Sea. J. Sea Res. 41 (3), 225-232.

SOVON, 2000. Atlas van de Nederlandse broedvogels 1998-2000. Nederlandse Fauna 5. NNM Naturalis, KNNV Uitgeverij and EIS, Leiden.

Spaans, A.L., 1998a. Breeding Lesser Black-backed Gull *Larus graellsii* in the Netherlands during the 20th century. Sula 12 (4): 175-184.

Spaans, A.L., 1998b. Breeding Herring Gull *Larus argentatus* in the Netherlands during the 20th century. Sula 12 (4), 185-198.

Ssymank, A. and Dankers, N., 1996. Red List of Biotopes and Biotope Complexes of the Wadden Sea Area. Helgoländer Meeresunters. 50, Suppl.: 9-37.

Stade Declaration, 1997. Ministerial Declaration of the Eighth Trilateral Governmental Conference on the Protection of the Wadden Sea. Stade, Germany, October 22, 1997.

STECF, 2005. Assessment of the ecological effectiveness of the Plaice Box Report of the STECF ad hoc working group 'To assess the effectiveness of the Shetland and Plaice Boxes in terms of conservation and sustainable exploitation'. Scientific, Technical and Economic Committee for Fisheries (STECF) pp. 81 (in prep).

Steenbergen J., Baars J.M.D.D., Stralen M.R. van, Kesteloo-Hendrikse J.J. and Bult T.P., 2003a. Het mosselareaal en –bestand op de droogvallende platen in de Waddenzee in het voorjaar van 2003. RIVO-report C070/03

Steenbergen, J. Stralen, M.R. van, Baars, J.M.D.D., and Bult, T.P., 2003b. Reconstructie van het areaal litorale mosselen in de Waddenzee in de periode najaar 1994-voorjaar 2002. RIVO report C076/03.

Steenbergen J., Baars, J.M.D.D., Kesteloo, J.J., Stralen M.R. van, and Bult, T.P., 2004. Het mosselbestand en areaal aan mosselbanken op de droogvallende platen in de Waddenzee in het voorjaar van 2004. RIVO-report C067/04.

Stelzenmüller V., Maynou, F., Ehrich, S. and Zauke, G.-P., 2004. Spatial analysis of twaite shad, Alosa fallax (Lacepède, 1803), in the Southern North Sea: Application of non-linear geostatistics as a tool to search for Special Areas of Conservation. International Review of Hydrobiology, 89: 337-351

Stienen, E.W.M., 2006. Living with gulls. Trading off food and predation in the Sandwich Tern Sterna Sandvichensis. PhD. Thesis, University of Groningen.

Stive, M.J.F., Capobianco, M., Wang, Z.B., Ruol, P. and Buijsman, MC., 1998. Morphodynamics of a tidal lagoon and the adjacent coast. In: J. Dronkers and M. Scheffers (eds.), Physics of estuaries and coastal seas. Balkema, Rotterdam, pp. 397-407.

Stock, M., F. Hofeditz, 2000. Der Einfluss des Salzwiesen-Managements auf die Nutzung des Habitates durch Nonnen- und Ringelgänse. In. Stock, M. & K. Kiehl (Eds.). Die Salzwiesen der Hamburger Hallig. Nationalpark Schleswig-Holsteinisches Wattenmeer. Landesamt für den Nationalpark Schleswig-Holsteinisches Wattenmeer, Tönning.

Stock, M., Gettner, S., Kohlus, J. and Stumpe, H., 2001. Flächenentwicklung der Festlandssalzwiesen in Schleswig-Holstein. Schriftenreihe Nationalpark Wattenmeer, Sonderheft 57-61.

Stock, M., F. Hofeditz, 2002. Einfluss des Salzwiesen-Managements auf Habitatnutzung und Bestandsentwicklung von Nonnengänsen Branta leucopsis im Wattenmeer. Vogelwelt, 123, 265-282.

Stock, M., 2002. Salzwiesenschutz im Wattenmeer. In: Lozán, J. L., Rachor, E., Reise, K., Sündermann, J. and Westernhagen, H. v. (Hrsg.). Warnsignale aus Nordsee and Wattenmeer - Eine aktuelle Umweltbilanz. Wissenschaftliche Auswertungen, Hamburg. 364-368.

Stock, M., 2003. Salzwiesenschutz im Schleswig-Holsteinischen Wattenmeer. Vogelkdl. Ber. Niedersachs. 35, 115-124.

Stock, M., Gettner, S., Hagge, M., Heinzel, K., Kohlus, J. and Stumpe, H., 2005. Salzwiesen an der Westküste von Schleswig-Holstein 1988 - 2001. Schriftenreihe Nationalpark Schleswig-Holsteinisches Wattenmeer, Heft 15, pp. 239..

Stock, M. and Hofeditz, F., 2003. Impact of sheep grazing on habitat utilisation of barnacle geese (*Branta leucopsis*) on salt marshes – implications for management. In: Wolff, W.J., K. Essink, A. Kellerman and M.A. van Leeuwe (Eds.). Proceedings of the 10th International Scientific Wadden Sea Symposium, pp. 89-106. Ministry of Agriculture, Nature Management and Fisheries and Department of Marine Biology, University of Groningen.

Stoddard, P., 2003. Reconstruction of blue mussel beds using arial potographs from 1989 and 2002 of the North Frisian Wadden Sea, Germany. Unpubl. Report, BioConsult SH, Hockensbüll.

Stralen, M.R. van, 2002. De ontwikkeling van mosselbestanden op droogvallende platen en in het sublitoraal van de Waddenzee vanaf 1955, een reconstructie op basis van gegevens uit de mosselzaadvisserij. MarinX-rapport 2001.10, Scharendijke, marinX, pp. 57.

Strasser, M. and Günther, C.-P., 2001. Larval supply of predator and prey: a temporal mismatch between crabs and bivalves after a severe winter in the Wadden Sea. J. Sea Res. 46: 57-67.

Strasser, M., Hertlein, A., Reise, K., 2001. Differential recruitment of bivalve species in the northern Wadden Sea after the severe winter of 1995/96 and of subsequent milder winters. Helgol. Mar. Res. 55: 182-189.

Strasser, M., 2002. Reduced epibenthic predation on intertidal bivalves after a severe winter in the European Wadden Sea. Mar. Ecol. Progr. Ser. 241: 113-123.

Strasser, M., Dekker, R., Essink, K., Günther, C.-P., Jaklin. S,, Kröncke, I., Brinch Madsen P., Michaelis, M., Vedel, G. 2002. How predictable is high bivalve recruitment in the Wadden Sea after a severe winter? J. Sea Res. 49: 47-57.

Stronkhorst, J., Schipper, C., Brils, J., Dubbeldam, M., Postma, J. and van de Hoeven, N., 2003. Using marine bioassays to classify the toxicity of Dutch harbour sediments. Environ. Toxicol. Chem. 22 (7): 1535-1547.

Stuurgroep Waddenprovincies, 2001. Monitoring Watersport op de Waddenzee. Resultaten 1998-2000, 28 pp.

Südbeck, P., Hälterlein, B., Knief, W. and Köppen, U., 1998. Bestandsentwicklung von Fluß-Sterna hirundo und Küstenseeschwalbe *S. paradisaea* an den deutschen Küsten. Vogelwelt 119, 147-163.

Südbeck, P. and Hälterlein, B., 1999. Brutvogelbestände an der deutschen Nordseeküste im Jahre 1997. Seevögel 20, 9-16.

Swennen C., Nehls G., Laursen K., 1989. Numbers and distribution of Eiders *Somateria mollissima* in the Wadden Sea. Neth. J. Sea Res. 24: 83-92.

Talbot, J.W., 1976. The dispersal of plaice eggs and larvae in the Southern Bight of the North Sea. J. Cons. int. Explor. Mer 37, 221-248.

Thiel, R., Sepulveda, A. and Oesmann, S., 1996. Occurrence and distribution of twaite shad (*Alosa fallax* Lacépède) in the lower Elbe estuary. J. Fish Biol. 46, 47-69.

Thieltges, D.W., Strasser, M. and Reise, K., 2003. The American slipper limpet *Crepidula fornicata* (L.) in the northern Wadden Sea 70 years after its introduction. Helgol. Mar. Res. 57, 27-33.

Thieltges, D.W., 2005. Impact of an invader: epizootic American slipper limpet *Crepidula fornicata* reduces survival and growth in European mussels. Mar. Ecol. Prog. Ser. 286:13-19

Thieltges, D.W., Strasser, M., Beusekom, J.E.E van, and Reise, K., 2004. Too cold to prosper – winter mortality prevents population increase of the introduced American slipper limpet Crepidula fornicata in northern Europe. J. Exp. Mar. Biol. Ecol. 311, 375-391.

Thorenz, F., 2001. Küstenschutz auf den Ostfriesischen Inseln: Aufgaben und Strategien. Wasser und Abfall 10/2001, 40-45.

Thorup, O. (compiler), 2006. Breeding waders in Europe: a year 2000 assessment. International Wader Studies 14, 3-131.

Thorup, O. and Meltofte, H., 2005. Birds. In: Zackenberg Ecological Research Operations, 10th Annual Report, 2004. Edited by Rasch, M. and Caning, K., Danish Polar Center, Ministry of Science, Technology and Innovation. pp. 43-51.

Thorup, O., 2005. Breeding Avocets in Denmark. Wader Study Group Bull. 107: 72-74.

Thyen, S., Becker, P.H., Exo, K.-M., Hälterlein, B., Hötker, H. and Südbeck, P., 1998. Monitoring breeding success of coastal birds. In: Wadden Sea Ecosystem No. 8, final report of the pilot study 1996-1997, 9-55. Trilateral Monitoring and Assessment Group, Wilhelmshaven.

Thyen, S., 2000. Verteilung und Schlupferfolg von Brutvögeln in landwirtschaftlich genutzten Außengroden Niedersachsens. Seevögel 21, 45-50.

Thyen, S. and Exo, K-M., 2003. Sukzession der Salzrasen an der niedersächsischen Küste: Chance oder Risiko für Brutvögel der Außengroden. Vogelkdl. Ber. Niedersachs. 35, 173-178.

Thyen, S. and Exo, K.M., 2005. Interactive effects of time and vegetation on reproduction of redshanks (*Tringa totanus*) breeding in Wadden Sea salt marshes. J. Ornithol. 146, 215-225.

Thyen, S., 2005. Reproduction of coastal breeding birds in the Wadden Sea: variation, influencing factors and monitoring. PhD. Thesis, University of Oldenburg.

Thyen, S., Büttcher, H. and Exo, K-M., 2005. Nistplatzwahl von Rotschenkeln *Tringa totanus* im Wattenmeer: Konsequenzen für Reproduktion, Prädation und Salzwiesen-Management. Die Vogelwelt 126, 365-369.

Tiews, K., 1978. The predator-prey relationship between fish populations and the stock of brown shrimp (*Crangon crangon* L.) in German coastal waters. Rapp. P.-v. Réun. Cons. Int. explor. Mer 172, 250-258.

Tiews K. and Wienbeck, H., 1990. Grundlagenmaterial zu '35-Jahrestrend (1954-1988) der Häufigkeit von 25 Fisch- und Krebstierbeständen an der deutschen Nordseeküste'. Veröff. Inst. f. Küsten- und Binnenfisch. 103, pp. 64.

Tiews K., 1990. 35-Jahrestrend (1954-1988) der Häufigkeit von 25 Fisch- und Krebstierbeständen an der deutschen Nordseeküste. Arch. Fisch Wiss. 40, 1/2, 39-48.

Timm, D. and Dahlmann, G., 1991. Investigations into the source of non-mineral oils in the feathers of seabirds. In: Camphuysen C.J. and J.A. van Franeker (Eds.). Oil pollution, Beached Bird Surveys and Policy: towards a more effective approach to an old problem. Proc. Int. NZG/NSO workshop, 19 April 1991, Rijswijk, Sula 5 (special issue), 15-17.

TMAG (Trilateral Monitoring and Assessment Group), 1997. TMAP Manual. The Trilateral Monitoring and Assessment Program (TMAP). Common Wadden Sea Secretariat, Wilhelmshaven.

Töppe, A., 1993. Longtime cycles in mean tidal levels. Proc Intern Workshop Seachange '93. Bundesanstalt für Gewässerkunde, IHP/OHP-Sekretariat, Koblenz, pp. 135-143.

Tougaard, S., Skov, H. and Kinze, C.C., 2000. Investigation of marine mammals in relation to the establishment of a marine wind farm on Horns Reef. - Fisheries and Maritime Museum, Esbjerg, Denmark, pp. 34.

Tougaard, J., Carstensen, J., Henriksen, O.D., Skov, H. and Teilmann, J., 2003. Short-term effects of the construction of wind turbines on harbour porpoises at Horns Reef. - Hedeselskabet, Roskilde, Denmark, pp. 72.

Trilateral Seal Expert Group-plus, 2002. Common and Grey seals in the Wadden Sea. Evaluation of the Status of Common and Grey Seal Populations in the Wadden Sea including an Assessment as to whether the Seal Management Plan needs to be revised and amended. TSEG-plus report to the TWG/SO, March/June 2001. Wadden Sea Ecosystem No. 15. Common Wadden Sea Secretariat, Wilhelmshaven, Germany, 81-93.

Trilateral Wadden Sea Plan, 1997. In: Ministerial Declaration of the Eighth Trilateral Governmental Conference on the Protection of the Wadden Sea, Stade, 1997, Annex 1. Common Wadden Sea Secretariat, Wilhelmshaven, pp. 13-83.

Tulp, I., 1998. Reproductie van Strandplevieren *Charadrius alexandrinus* en Bontbekplevieren Charadrius hiaticula op Terschelling, Griend en Vlieland in 1997. Limosa 71, 109-120.

Tulp, I., Willigen, J.A. van and Leeuw, J.J. de, 2002. Diadrome vis in de Waddenzee: resultaten van monitoring 2000-2002. RIVO rapport nr. C065/02.

Umweltbehörde Hamburg (Hrsg.), 2001. Nationalpark-Atlas Hamburgisches Wattenmeer. Naturschutz und Landschaftspflege in Hamburg, Nr. 50:168 pp.

Vaas, A. and Melter, J. 2005. Untersuchung zum Bruterfolg des Säbelschnäblers Recurvirostra avosetta in der Leybucht 2005. Im Auftrag der Nationalparkverwaltung Niedersächsisches Wattenmeer, Wilhelmshaven. BioConsult OS, Osnabrück

Van der Meulen, MJ (Ed.), 2004. Evaluatie Landelijke Beleidsnota Schelpenwinning, Rijkswaterstaat, Dienst Weg- en Waterbouwkunde, Delft.

van Roomen, M., van Turnhout, C., van Winden, E., Koks, B., Goedhart, P., Leopold, M. and Smit, C.J., 2005. Trends van benthivore watervogels in de Nederlandse Waddenzee 1975-2002: grote verschillen tussen schelpdiereters en wormeneters. Limosa 78, 21-38.

Vauk, G. Dahlmann, G., Hartwig, E., Ranger, J.C., Reineking, B., Schrey, E., and Vauk-Hentzelt, E., 1987. Ölopfererfassung an der deutschen Nordseeküste und Ergebnisse der Ölanalysen sowie Untersuchungen zur Belastung der Deutschen Bucht durch Schiffsmüll. Report Vogelwarte Helgoland, Umweltbundesamt Berlin, pp.164.

Vauk, G., E. Hartwig, E. Schrey, E. Vauk-Henzelt, and M. Korsch, 1989. Seevögelverluste durch Öl und Müll an der deutschen Nordseeküste von August 1983 bis April 1988. - Umweltbundesamt, Wasser Forschungsbericht 102 04 370, pp. 164.

Veer, M.A.C., 1997. Nitrogen availability in relation to vegetation changes resulting from grass encroachment in Dutch dry dunes. J. Coast. Cons. 3: 41-48.

VenW, (1998) Landelijke Beleidsnota Schelpenwinning. Ministerie van Verkeer en Waterstaat, Den Haag.

VenW (2001) Partiële herziening Landelijke Beleidsnota Schelpenwinning. Ministerie van Verkeer en Waterstaat, Den Haag.

Verhulst S., Oosterbeek, K., Rutten, A.L. and Ens, B.J., 2004. Shellfish fishery severely reduces condition and survival of oystercatchers despite creation of large marine protected areas. Ecology and Society 9 (1): 17. www.ecologyandsociety.org/vol9/iss1/art17.

Viebahn, C. von, 2001. Oil spill statistics and oil spill monitoring. DGMK research report 564. Hamburg, DGMK, pp. 95.

Vorberg, R., 1995. On the decrease of sabellarian reefs along the North Sea coast. Publ. Ser. Géol. Lux. 29: 87-93.

Vorberg, R., 1997. Auswirkungen der Garnelenfischerei auf den Meeresboden und die Bodenfauna des Wattenmeeres. Schriftenreihe naturwissenschaftliche Forschungsergebnisse Bd 54, Hamburg, Dr. Kovac Verlag, pp.191.

Vorberg, R. and Breckling, P., 1999. Atlas der Fische im schleswig-holsteinischen Wattenmeer. Schriftenreihe des Nationalparks Schleswig-Holsteinisches Wattenmeer, Heft 10, pp. 178.

Vorberg, R., 2000. Effects of shrimp fisheries on reefs of *Sabellaria spinulosa* (Polychaeta). ICES Journal of Marine Science 57: 1416-1420.

Vorberg, R., 2001. Zehn Jahre Fischmonitoring. In: Landesamt für den Nationalpark Schleswig-Holsteinisches Wattenmeer (Hrsg.): Wattenmeermonitoring 2000. - Schriftenreihe des Nationalparks Schleswig-Holsteinisches Wattenmeer, Sonderheft, 21-23.

Vorberg, R., 2003. Sardelle wieder im deutschen Wattenmeer heimisch. Das Fischerblatt 2003/Nr. 1, 4-6.

Wadden Sea Forum, 2005. Breaking the ice. Final Report of the Wadden Sea Forum, February 2005, Wadden Sea Forum. Wilhelmshaven, Germany, pp. 72

Wang, Z.B. and van der Weck, A., 2002. Sea-level rise and morphological development in the Wadden Sea, a desk study. WL | Delft Hydraulics, Report Z3441.

Wanink, J.H., 1999. Effecten van klimaatveranderingen op aquatische gemeenschappen. Literatuurstudie voor het project WIN, Koeman en Bijkerk B.V., Haren. Rapport 99-46.

WASA, 1998. Changing waves and storms in the Northeast Atlantic? Bull. Amer. Meteorol. Soc. 79: 741-760.

Wehrmann, A., A. Markert, P.May, P. Schieck & A. Schmidt, 2006. Gefährdungspotential der eulitoralen Miesmuschelbänke im Niedersächsischen Wattenmeer durch die Bioinvasion der Pazifischen Auster *Crassostrea gigas*. Abschlussbericht Projekt 7/02 der Niedersächsischen Wattenmeer-Stiftung, Wilhelmshaven.

Wehrmann, A., Herlyn, M., Bungenstock, F., Hertweck, G. and Millat, G., 2000. The distribution gap is closed – first record of naturally settled Pacific oysters Crassostrea gigas in the East Frisian Wadden Sea. Senckenbergiana marit. 30, 153-160.

Weisse, R., Fönther, H. and Feser, F., 2002. A 40-year high-resolution wind and wave hindcast for the Southern North Sea. Proc. 7th Internat Workshop on Wave Hindcasting and Forecasting, Banff, Canada: 97-104.

Weisse, R., von Storch, H. and Feser, F., 2004. Northeast Atlantic and North Sea storminess as simulated by a regional climate model 1958-2001 and comparisons with observations. J. Climate.

Werkman, G., Eggens, M.L. and van de Ven, C.L.M., 2000. Water quality and eider ducks in the Wadden Sea. Report RIKZ/AB/20000.607x (in Dutch).

Wetlands International, 2002. Waterbird Population Estimates - Third Edition. Wetlands International Global Series No. 12, Wageningen, The Netherlands. 182 p.

Wijsman, J. W. M., M. van Stalen, M. Dubbeldam, R. Geene, M. de Kluijver, E. van Zanten & A. C. Smaal 2006. Wegvisproef Japanse oesters in de Oosterschelde. Tussentijdes rapportage T2. Wageningen IMARES Rapport nr. C077/06.

Wille V., 2000. Grenzen der Anpassungsfähigkeit überwinternder Wildgänse an anthropogene Nutzungen. PhD Thesis, Univ. Osnabrück. Cuvillier, Göttingen.

Willems, F., Oosterhuis, R., Dijksen, L., Kats, R.K.H. and Ens, B.J., 2005. Broedsucces van kustbroedvogels in de Waddenzee 2005. Sovon-onderzoeksrapport 2005/07. SOVON, Beek-Ubbergen.

Wintermans, G.J.M. and Jager, Z., 2001. Verslag visintrek Waddenzeekust voorjaar 2001. WEB-rapport 01-04.

Wintermans, G.J.M. and Jager, Z., 2002. Verslag visintrek Waddenzeekust voorjaar 2002. WEB-rapport 02-04; Werkdocument RIKZ/OS/2002.610x.

Wintermans, G.J.M. and Jager, Z., 2003. Verslag visintrek Waddenzeekust voorjaar 2003. WEB-rapport 03-03; Werkdocument RIKZ/OS/2003.602x.

Witte, G., 1997. Bescherming van de Dwergstern op Texel. Graspieper 96 (4), 124-138.

Witte, J.Y. and Zijstra, J.J., 1978. The species of fish occurring in the Wadden Sea. In: Dankers, N.; Wolff, W. J. and Zijlstra, J.J. (Eds.), 1978. Fishes and fisheries in the Wadden Sea. Report 5 of the final report of the section 'Fishes and fisheries' of the Wadden Sea Working Group. Stichting Veth tot Steun aan Waddenonderzoek, Leiden, 5-19.

Witte, J.Y., Dapper, R., Noort, G.J. van and Veer, H.W. van der, 1991. De verspreiding van vissen op het Nederlands continentaal plat van de Noordzee., Netherlands Institute for Sea Research, pp. 110.

Wolff, W.J.(Ed.), 1983. Ecology of the Wadden Sea. Balkema, Rotterdam.

Wolff, W.J., 2000. Causes of extirpations in the Wadden Sea, an estuarine area in The Netherlands. Conservation Biology 14, 876-885.

Wolff, W.J. and Reise, K., 2002. Oyster imports as a vector for the introduction of alien species into northern and western European coastal waters. In: Leppäkoski, E., Gollasch, S., Olenin, S. (Eds.). Invasive aquatic species of Europe. Kluwer Academic Publ., Dordrecht, 193-205.

Wolff, W.J. 2005. Non-indigenous marine and estuarine species in The Netherlands. - Zool. Med. Leiden 79: 1-116. Wolff, W.J. and Reise, K. 2002. Oyster imports as a vector for the introduction of alien species into northern and western European waters. - In : Leppäkoski, E., Gollasch, S. and Olenin, S. (eds), Invasive aquatic species of Europe. Distribution, impacts and management. Kluwer, Dordrecht: 193-205

Wolters, M. Restoration of salt marshes. Ph.D. thesis, Rijksuniversiteit Groningen, pp. 168.

Zegers, B.N., Lewis, W.E., Booij, K., Smittenberg, R.H., Boer, W., de Boer, J. and Boon, J.P., 2003. Levels of polybrominated diphenyl ether flame retardants in sediment cores from Western Europe. Environ. Sci. Technol. 37, 3803-3807.

Zijlstra, J.J., 1972. On the importance of the Wadden Sea as a nursery area in relation to the conservation of the southern North Sea fishery resources. Symp. zool. Soc. Lond. 29, 233-258.

Zijlstra, J.J., 1978. The function of the Wadden Sea for the members of its fish-fauna. In: Dankers, N.; Wolff, W.J. and Zijlstra, J.J. (Editors). Fishes and fisheries in the Wadden Sea. Report 5 of the final report of the section 'Fishes and fisheries' of the Wadden Sea Working Group. Stichting Veth tot Steun aan Waddenonderzoek, Leiden, 20-25.

Zimmermann, C., 1998. Aktuelle Entwicklung der Herings- und Sprottenbestände südlich des 62. Breitengrades. Inf. Fischwirtschaft 45 (2), 68-72.

Zöckler, C., 2005. Migratory bird species as indicators for the state of the environment. Biodiversity 6, 7- 13.

Zöckler, C., 2007. Trends in arctic birds migrating to the Wadden Sea. In: Reineking, B. and Südbeck, P. (Eds.). Seriously declining trends in migratory waterbirds: Causes-Concerns-Consequences. Proceedings of the International Workshop on 31 August 2006 in Wilhelmshaven, Germany. Wadden Sea Ecosystems No. 23. Common Wadden Sea Secretariat, Wadden Sea National Park of Lower Saxony, Institute of Avian Research, Joint Monitoring Group of Migratory Birds in the Wadden Sea, Wilhelmshaven, Germany, p. 33 – 42.

Annex 10

Joint Declaration on the Protection of the Wadden Sea, 1982

Joint Declaration on the Protection of the Wadden Sea
9th December 1982

The Netherlands Germany Denmark

THE GOVERNMENTS of the Kingdom of Denmark, the Federal Republic of Germany and the Kingdom of the Netherlands;

CONSIDERING that the Waddensea region is a unique natural area whose biological, scenic and scientific significance is of international importance;

RECOGNIZING the special importance of the Waddensea region as a natural entity, as a vital element in the west-palearctic flyway for migratory birds and as a nursery for marine organisms;

RECOGNIZING their responsibilities for the conservation of the ecosystem and the biological values of this region and its components as well as its natural beauty;

BEARING IN MIND the obligations resulting from international legal instruments relevant in the field of natural environment protection, in particular:

- the Convention on Wetlands of international importance especially as Waterfowl Habitat (Ramsar, 2 February 1971);
- the Convention on the Conservation of Migratory Species of Wild Animals (Bonn, 23 June 1979);
- the Convention on the Conservation of European Wildlife and Natural Habitats (Bern, 19 September 1979);
- the relevant EEC-Council Directives, especially that of 2 April 1979 on the protection of wild
- birds (supplemented by the council resolution of 2 April 1979);

DECLARE THEIR INTENTION

1 to consult each other in order to coordinate their activities and measures to implement the above mentioned legal instruments with regard to the comprehensive protection of the Waddensea region as a whole including its fauna (marine, terrestrial and avian) and flora with special emphasis on
- resting and breeding areas for seals,
- areas being important as resting, feeding, breeding, or moulting grounds for waterfowl, both in themselves and in their interdependencies;

2 to this end to intensify and broaden the contacts between their responsible administrations. The results of these consultations will be examined and, as appropriate, decided upon at Dutch-German-Danish meetings on governmental level about the Waddensea.

Done at Copenhagen in English this 9th day of December 1982 in three original copies each being authentic.

For the Government of the Kingdom of Denmark
Christian Christensen
For the Government of the Federal Republic of Germany
Hans Jürgen Rohr
For the Government of the Kingdom of the Netherlands
G.J.M. Braks

Annex 11

Administrative Agreement on a Common Secretariat for the Cooperation on the Protection of the Wadden Sea, 1987

14.07.1987

Administrative Agreement

on a Common Secretariat for the Cooperation on the Protection of the Wadden Sea

between

the Ministry of the Environment of Denmark,

the Federal ministry for the Environment, Nature Conservation and Nuclear Safety of the Federal Republic of Germany

and

the ministry of Agriculture and Fisheries of the Netherlands.

The Ministry of the Environment of Denmark and the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety of the Federal Republic of Germany and
the ministry of Agriculture and Fisheries of the Netherlands,
hereinafter referred to as the Parties,

MINDFUL of the Joint Declaration dated 9 December 1982
of the Federal Republic of Germany, the Kingdom of Denmark and the Kingdom of the Netherlands on
the Protection of the Wadden Sea and its implementation,

TAKING INTO ACCOUNT the conclusions arrived at in connection with the 4th trilateral governmental conference on the Wadden Sea in the Hague on 12 September 1985,

have agreed as follows:

Article I

(1) The Parties shall establish a Common Secretariat for their cooperation on the protection of the Wadden Sea.

(2) The duties of the Common Secretariat shall be carried out by a Secretary who is provided with adequate administrative support.

Article 2

(1) The Common Secretariat shall have the following duties relevant to the cooperation of the Parties on the protection of the Wadden Sea.

a) to provide assistance with regard to trilateral

- governmental conferences;
- consultations on policy and other relevant matters between senior government officials;
- consultations at the policy preparing and technical level within the framework of working groups;
- consultations of the representatives referred to in Article 3.

b) - to collect and disseminate information on conservation measures;
- to analyse legal instruments and/or other means in each country, in existence or needed, in order to fulfil the obligations resulting from the instruments mentioned in the Joint Declaration.

c) - to provide assistance with regard to trilateral meetings on practical management in the field of nature conservation.

d) - to collect information on activities that have or may have significant effects on the natural environment in the Wadden Sea, to identify and signal such activities and give suggestions for appropriate action.

e) - to promote or take care of, as appropriate, compilation, updating and evaluation of lists on completed and current research projects;
- to make proposals for closer scientific cooperation;
- to promote or take care of, as appropriate, the identification of needs and priorities for scientific research;
- to promote or take care of, as appropriate, the publication of expert information.

f) - to provide assistance with regard to scientific symposia.

g) - to make suggestions for a coordinated approach by the Parties in international fora;
- to make an assessment of measures being taken or to be taken by other states adjacent to the North Sea and by the European Communities.

h) - to prepare drafts for the annual work programme and budget;
   - to prepare and propose financial statements.

i) - further duties assigned to it by the representatives, e.g. providing assistance with regard to future trilateral agreements.

(2) Suggestions and proposals concerning the items mentioned in the preceding paragraph, can only be presented by the Common Secretariat to the representatives or in trilateral working groups in accordance with the representatives. The external functioning of the Common Secretariat in the framework of its duties shall furthermore require the approval of 'the Chairman of the representatives.

(3) The senior government officials shall establish, on the proposal of the representatives, the annual work programme to be carried out by the Common Secretariat.

Article 3

(1) The Parties each shall appoint a representative to jointly supervise the performance of the duties of the Common Secretariat.

(2) The group of representatives shall be chaired by the representative of the Party responsible for hosting the next trilateral governmental conference. The chairman shall supervise the functioning of the Common Secretariat. He shall issue assignments to the Secretary in accordance with the representatives of the other two states. The chairman of the group of representatives shall be the Secretary's immediate superior.

(3) Differences among the representatives as to the functioning of the Secretariat shall be referred to the senior government officials, appointed by each Party, and settled by them using the appropriate means.

Article 4

(1) The Common Secretariat shall have an annual budget, covering the costs of the Secretariat. Office facilities are provided by the party, where the Secretariat is located; normally outside the budget.

(2) Each of the Parties shall finance one third of the annual budget.

(3) The budget shares of the Parties shall be paid at the beginning of every budget year. The accounts shall be closed at the end of the same year.

(4) The senior government officials - each in accordance with national practices - shall adopt on the proposal of the representatives the annual budget and the financial statements, including the salaries of the personnel of the Common Secretariat.

Article 5

The working language of the Secretariat is English.

Article 6

The legal status of the Common Secretariat, including that of its personnel, is determined by the laws of the country in which the Secretariat is located. The Party in whose country the Secretariat is located shall be the formal employer of the Secretary.

Article 7

(1) The Common Secretariat shall first be established in the Federal Republic of Germany.

(2) The next location of the Common Secretariat shall be decided at the latest at the next trilateral governmental conference on the basis of a proposal presented by the Party organizing and hosting the subsequent conference (Denmark, and subsequently the Netherlands, The Federal Republic of Germany and so forth).

(3) The Common Secretariat shall be attached to a national public institution in the country where it is located without prejudice to the provisions of Article 3 (2).

Article 8

(1) The chairman of the group of representatives proposes in agreement with the other representatives a candidate for appointment as Secretary. The Secretary shall be first appointed by the German side. The next Secretary is appointed by the Party referred to in Article 7 (2).

(2) The Secretary is appointed for the period between two trilateral governmental conferences, which is normally 3 years.

(3) The Secretary's qualifications shall be university level or equivalent, and his salary shall be set at a corresponding level.

(4) important decisions concerning the Secretary, including possible dismissal, are taken by hat Party, which appointed the Secretary, in agreement with the other representatives.

Article 9

This Agreement shall also apply to Land Berlin, provided that the government of the Federal Republic of Germany does not make a contrary declaration to the other two Parties within 3 months of the date of entry into force of this agreement.

Article 10

(1) This Agreement can only be amended with the consent of the three Parties.

(2) Each Party may denounce this Agreement by written notification to the other Parties. The denunciation shall take effect 12 months after the last Party has received the notification, in no circumstances however prior to expiry of the period for which the secretary is appointed.

Article 11

This Agreement shall enter into force 10 days after it has been signed by the last Party and has been notified to the other Parties.

The Minister for Environment of Denmark

Kopenhagen
Date: 13.10.1987

The Federal Minister for the Environment, Nature Conservation and Nuclear Safety of the Federal Republic of Germany

Bonn
Date: 28.9.1987

The Minister for Agriculture and Fisheries of the Netherlands
Gravenhage

Date: 30.9.1987

Annex 12

Stade Declaration
Trilateral Wadden Sea Plan (WSP), 1997

Cover note

The Trilateral Wadden Sea Plan was adopted at the 8th Wadden Sea Conference in Stade, Germany in 1997. The Wadden Sea Plan (WSP) constitutes the common trans-boundary policy and management for the Wadden Sea Area. The Wadden Sea Plan applies to both the nominated property “The Wadden Sea” and the adjacent areas covered by the Wadden Sea cooperation.
The Wadden Sea Plan is an essential element of the management system of the nominated property.
This management system is a combination of the national management systems and the trilateral Wadden Sea Plan aiming at securing a coordinated management of the trans-boundary site located on the territory of two sovereign states, the Federal Republic of Germany and the Kingdom of the Netherlands and incorporating responsible authorities.

Stade Declaration
Trilateral Wadden Sea Plan

Ministerial Declaration of the
Eighth Trilateral Governmental Conference
on the Protection of the Wadden Sea

Stade, October 22, 1997

Foreword

The adoption of the Stade Declaration and the Wadden Sea Plan mark two decades of nature cooperation between The Netherlands, Germany and Denmark. It is a token of twenty years of joint responsibility for the protection of a nature area of outstanding importance, both national and international.

During the first decade of the trilateral Wadden Sea Cooperation the emphasis was on the protection of birds and seals.

By the end of the eighties a start was made with a more integrated approach to nature conservation. At the 6th Governmental Wadden Sea Conference, Esbjerg 1991, the whole range of human activities in the Wadden Sea was addressed. Three years later, at the Leeuwarden Conference, the regulation of human use was embedded in a system of ecological targets for all typical Wadden Sea habitats.

The adoption by the 8th Wadden Sea Conference in Stade, Germany, 1997, of the Stade Declaration and the Trilateral Wadden Sea Plan, may be valued as the accumulated achievement of almost twenty years of political cooperation on international nature conservation.

The Stade Conference is at the same time the starting point of a new phase in the trilateral Wadden Sea Cooperation which will be dedicated to the integration of nature conservation and human use on the basis of the common Targets and the catalogue of measures for achieving the Targets as laid down in the Trilateral Wadden Sea Plan.

The active involvement of all stakeholders in this process is one of the major challenges for the years to come. Our efforts to protect and develop the area in a sustainable way can only succeed if all those who work and live in the area, are committed to this objective.

A start with this involvement was made during the public discussions accompanying the preparation of the Wadden Sea Plan. We thank all those who have actively taken part in these discussions.

Angela Merkel

Svend Auken

Josias van Aartsen

Stade Declaration

The MINISTERS responsible for the protection of the Wadden Sea Area[1] of Denmark, The Netherlands and the Federal Republic of Germany met at the 8th Trilateral Governmental Conference on the Protection of the Wadden Sea (the Stade Conference) in Stade on 22 October 1997 to reinforce, further develop and enhance their joint cooperation, building upon the agreements made at previous Wadden Sea Conferences, in particular, at the Esbjerg Conference, 1991, and the Leeuwarden Conference, 1994.

They note the progress made in the protection of the Wadden Sea since the Leeuwarden Conference in 1994 as entailed in the Progress Report. They reaffirm that efforts must continuously be made to conserve and protect the area for coming generations in accordance with AGENDA 21[2] and the Convention on Biological Diversity and that the implementation of agreed policies and measures must be undertaken in dialog with the stakeholders.

The Wadden Sea Area is an area of outstanding ecological importance. They acknowledge their global responsibility for this area. The Wadden Sea Area is also an area where people live, work and recreate. Safety of the inhabitants is of utmost importance. Conditions for sustainable economic developments must be maintained.

There is a close interrelationship between the Wadden Sea Area and its surroundings. On the one hand, areas adjacent to the Wadden Sea Area can benefit from the values of the Wadden Sea. On the other hand, developments and activities outside the Wadden Sea Area may have an impact on the values of the Wadden Sea Area. The benefits should be improved and the negative impacts addressed.

They acknowledge the statements submitted by the non-governmental organisations, the Joint Statement of the Dutch-German-Danish Wadden Sea Advisory Councils, the Joint Statement of the Inter-regional Wadden Sea Cooperation and the common resolutions of the Dutch-German-Danish Wadden Sea Island Cooperation as valuable contributions to inspire, stimulate and advance the Trilateral Wadden Sea Cooperation.

They appreciate the efforts made by the Inter-regional Wadden Sea Cooperation to contribute to the work of the trilateral cooperation, in particular, with regard to the issues of environmental impact assessment and sustainable tourism and acknowledge that the close collaboration has been of mutual benefit.

[1] The Wadden Sea Area is the Trilateral Area of Cooperation as defined in§9 of the Leeuwarden Declaration.
[2] Chapter 17 on the "Protection of oceans, all kinds of seas, including semi-enclosed seas, and coastal areas and the protection, rational use and development of their living resources" and chapter 15 on the "Conservation of biological diversity".

They appreciate the work carried out so far by the QSR Group in preparing the Wadden Sea Quality Status Report and take note of the assessment of the Wadden Sea ecosystem as entailed in the Assessment Report.

The Ministers, in the exercise of their political responsibilities, AGREE on the following[3]:

Wadden Sea Plan

1 The Ministers AGREE to adopt the Wadden Sea Plan in Annex I, elaborated in accordance with the Leeuwarden Declaration, entailing the common policies, measures, projects and actions of the countries for their joint efforts to fulfill the Targets.

2 The Ministers AGREE to consider and, where necessary, amend the Wadden Sea Plan at the next Trilateral Wadden Sea Conference in accordance with the procedure outlined in the Plan and the Leeuwarden Declaration.

3 The Ministers ACKNOWLEDGE that the success of implementing the Wadden Sea Plan, a.o., depends on the extent to which relevant authorities, interest groups and local citizens contribute to the realization of the policies and measures.

4 Inhabitants, users, visitors and all stakeholders in the Wadden Sea region are invited to provide their ideas and inputs through the Wadden Sea Plan to the implementation of the Targets.

5 The Ministers URGE the competent national authorities to maintain or intensify their cooperative dialogue with all stakeholders involved, in order to promote public acceptance of the Wadden Sea Plan and thus to promote the idea of sustainable use of the natural resources of the Wadden Sea Area, for the long-term benefit of everyone living and working in the Wadden Sea Area. This includes the information of the local population in the national languages.

6 The Ministers WELCOME the suggestions presented during the Conference and the resolutions of the non-governmental organisations, the Dutch-German-Danish Wadden Sea Advisory Councils, the Inter-regional Wadden Sea Cooperation and the Dutch-Danish Wadden Sea Island Cooperation and EMPHASIZE that these suggestions should be further taken into consideration in the above mentioned dialogue with all stakeholders.

7 The Ministers RECOGNIZE the important contribution different types of co-management schemes can make in appropriate circumstances, at various levels and in many aspects of Wadden Sea management and WELCOME further research in this field.

8 The Ministers STRESS the fundamental need to protect the local population against storm floods and they take care that the implementation of the Wadden Sea Plan will not impair safety standards.

9 The Ministers ACKNOWLEDGE the responsibility of the Wadden Sea States to maintain the safety on international and national shipping routes and they ENCOURAGE the competent authorities, which are responsible for safe and easy access to sea ports and their management, to take into account the recommendations of the Wadden Sea Plan.

[3] Throughout this Declaration the term 'agree' is to be understood as defined in this paragraph.

10 The Ministers URGE the competent national authorities to exchange views and to communicate with all stakeholders involved in the implementation of the Wadden Sea Plan, and they EXPECT the local population and local communities to be actively involved in the formulation of proposals, which will be taken into consideration at the next Wadden Sea Conference and which will improve and bring the Wadden Sea Plan up-to-date.

11 The Ministers AGREE that the implementation of the Wadden Sea Plan will be evaluated and assessed carefully during the coming years and that a progress report be submitted to the next Wadden Sea Conference, providing the basis for the further development of the Wadden Sea Plan. Special consideration should be given to the islands in the Wadden Sea Area. The Ministers PUT their senior officials IN CHARGE of supervising the assessment and evaluation of the implementation of the Plan.

12 The Ministers REGARD the Wadden Sea Plan as a good example of international cooperation on a shared nature area and ENDORSE its submission to appropriate international conferences in the field of environmental and nature cooperation.

External Impacts

13 The Ministers HIGHLIGHT the fact that the quality of the Wadden Sea Area may be influenced significantly by activities taking place outside or pollution stemming from sources outside the Wadden Sea Area. The Ministers REGARD the large areas of "black spots" in the East Frisian Wadden Sea during 1996 as a sign of impairment of the decomposition capacity of the benthic system, one of the major functions of the Wadden Sea ecosystem. The Ministers, therefore, AGREE that the three countries will join their efforts within international fora, as well as, in negotiations with other parties towards fulfilling the following goals:

Reduction of inputs of nutrients, hazardous substances and oil

14 They RECOGNIZE the importance of the catchment areas of the debouching rivers for the quality of water, sediment and marine habitats and ACKNOWLEDGE that the total load of hazardous substances and phosphorus compounds entering the Wadden Sea Area via the rivers has been reduced considerably during the last 10 years but that oil pollution from shipping is still a problem.

15 They INSIST that the total load of nutrients entering the Wadden Sea Area must be reduced significantly. Existing international agreements and EU regulations in this field must be implemented rigorously. Especially important are the following measures:
- to equip, as soon as possible, waste water treatment plants in the catchment area of the North Sea and Wadden Sea with nutrient treatment stages;
- to promote extensification of agricultural practices - also through EU-programs - and to reduce ammonia emissions from agriculture;
- to reduce emissions from traffic.

16 They UNDERLINE that the reduction of inputs of hazardous substances and oil needs to be continued and that specific efforts need to be undertaken in the adjacent ports and in all river systems entering the Wadden Sea. The pollution, especially by oil from shipping, needs further reduction, in particular, by providing cost effective and customer-friendly port reception facilities.

17 They strongly URGE all competent authorities to consider the common interests of the Wadden Sea Area and to reduce, where this is necessary, the environmental impacts of, in particular, harbor and industrial facilities, recreation, civil air traffic, military activities, wind energy, agriculture and traffic, inter alia by taking specifically into account, in EIA procedures, the needs of the Wadden Sea ecosystem, the Common Principles and relevant EU Directives. Moreover, in dealing with such activities and in applying relevant national and EU regulations, decision makers should strive for both a net social benefit and a net positive ecological outcome.

EC Bird and Habitat Directives

18 The Ministers NOTE that major parts of the Wadden Sea Area have been listed as a habitat area by the competent authorities in accordance with Art. 4 of the EC Habitat Directive and/or Art. 4 of the EC Bird Directive and that the list has been transmitted to the European Commission. The Schleswig-Holstein part of the Wadden Sea has also been prepared to be nominated as Special Protection Area under the EC Bird Directive as the last remaining part of the Wadden Sea Area. A majority of the Wadden Sea Area is hence, now part of NATURA 2000.

19 The Ministers RECOGNIZE that there are differences in the delimitations of the listed areas and, therefore, AGREE to work further towards a more coherent Natura 2000 area for the Wadden Sea.

Trilateral Monitoring and Assessment Program

20 The Ministers APPRECIATE the work exercised by the Trilateral Monitoring and Assessment Working Group (TMAG) in elaborating the report on the "Implementation of the Trilateral Monitoring and Assessment Program (TMAP)" in fulfillment of §67 of the Leeuwarden Declaration. The work has been carried out in the framework of the DEMOWAD-project co-financed by the European Commission under the LIFE Program.

21 The Ministers AGREE to implement the common package of parameters as in Annex 2 and, to this end, establish, as soon as possible, the necessary financial and organizational preconditions for its implementation, including the associated data management.

22 The Ministers AGREE to an evaluation of experiences with this common package at the next Wadden Sea Conference.

Particularly Sensitive Sea Area Wadden Sea

23 The Ministers NOTE the progress being made within the International Maritime Organization (IMO) to reduce the environmental impact of shipping on sensitive sea areas like the Wadden Sea, especially with the mandatory routeing measures for oil- and chemical tankers off the Dutch and German Wadden Sea coast.

24 The Ministers NOTE that all relevant measures have been taken inside the Wadden Sea Area or in the adjacent area according to the conditions for Particularly Sensitive Sea Areas (PSSAs) as required by the IMO.

25 The Ministers ENDORSE a study on the possibilities for a proposal to the IMO to designate the Wadden Sea and an adjacent zone as Particularly Sensitive Sea Area (PSSA).

Environmental Impact Assessment

26 The Ministers WELCOME the work carried out by the Interregional Wadden Sea Cooperation (IRWC) pursuant to §§ 26-27 of the Leeuwarden Declaration and its decisions with regard to Environmental Impact Assessments (EIAs).

27 The Ministers INVITE relevant competent authorities, when deciding on thresholds and/or criteria for Annex II projects of EC Directive 97/11/EEC, to give special consideration to the significant effects these projects are likely to have on the Wadden Sea Area.

28 The Ministers AGREE on their intention, when applying the information and consultation procedures of the ECE Convention on Environmental Impact Assessment in a Transboundary Context, to consider the specific vulnerability of the Wadden Sea Area.

29 The Ministers RECOMMEND that in the assessment of plans and projects in the Wadden Sea Area, alternatives should be considered following the EC Habitat Directive. In this context social and economic aspects should be taken into account, as appropriate.

International Cooperation

The Wash - Wadden Sea Cooperation

30 The Ministers AGREE to continue to cooperate by establishing projects in the field of exchange of information and experiences on monitoring, management of the common seal population and on establishing an improved collaboration between management authorities.

Guinea Bissau - Wadden Sea Cooperation

31 The Ministers AGREE to continue the collaboration in the context of the Memorandum of Intent by signing a new three-year work program as in Annex 3 which continues and builds upon the experiences and results of the first work program with the aim of finalizing the training of an ornithological team and to establish an organization to support and further develop management and public awareness in the area.

Brent Goose Management Plan

32 The Ministers INVITE The Netherlands to proceed with finalizing the preparation of the International Management Plan for the Brent Goose and prepare the drafts and attached actions for decisions by the First Meeting of the African-Eurasian Waterbird Agreement (AEWA).

Conservation of Seals and Small Cetaceans

33 The Ministers ACKNOWLEDGE the Conservation and Management Plan for the Wadden Sea Seal Population 1996-2000 elaborated and endorsed in the framework of the Seal Agreement as being the elaboration of the Targets on Common and Grey Seals entailed in the Wadden Sea Plan.

34 The Ministers WELCOME that a network will be organized for the collection of information on by-catch of harbor porpoises in the framework of the Agreement on Small Cetaceans of the Baltic and the North Sea (ASCOBANS) which is also relevant for the Wadden Sea Area and the area seaward of the Wadden Sea Area.

Cooperation in the Field of Public Information

35 The Ministers AGREE to explore possibilities to enhance the quality of public participation and WELCOME the initiative of The Netherlands to organize a workshop for that purpose.

Tourism Development

36 The Ministers ACKNOWLEDGE the work carried out by the Inter-regional Wadden Sea Cooperation regarding the analysis and visions of sustainable tourism development and recreational use in the Wadden Sea region.

The Ministers AGREE to initiate interregional cooperation to develop and implement policies on sustainable tourism, together with relevant stakeholders, as well as, local and other relevant authorities. They INVITE the Inter-regional Wadden Sea Cooperation to carry out this task.

Cultural Heritage

37 The Ministers TAKE NOTE of the results of the workshop on Cultural Heritage held in Ribe, Denmark and DECIDE that the planned mapping of cultural heritage in the Wadden Sea Area will be extended to relevant adjacent parts of the Wadden Sea Area.

Future Cooperation

Scientific Wadden Sea Symposium

38 The 10th International Scientific Wadden Sea Symposium will be held at the invitation of the Dutch Government.

9th Wadden Sea Conference

39 Denmark will chair the cooperation from January 1, 1998. The 9th Wadden Sea Conference will be held in Denmark in 2001.

Signatures

For the Government of the Federal Republic of Germany

Dr. A. Merkel

For the Government of the Kingdom of Denmark

S. Auken

For the Government of the Kingdom of The Netherlands

J.F. de Leeuw

Annex I
Trilateral Wadden Sea Plan

Contents

Preface

The Wadden Sea: into the next Millennium

1 The Wadden Sea is an area of outstanding natural value. It is characterized by a high biological productivity and high natural dynamics. The Wadden Sea is the largest European wetland area and its tidal flats form the largest unbroken stretch of mudflats worldwide.

2 The Wadden Sea area has been inhabited for thousands of years. In the beginning, the population lived mainly from hunting and fishery. Together with permanent settling and the development of agriculture, land reclamation became an important activity. In the course of the last century, and especially since the end of World War II, the influence of humans has increased with growing technical possibilities and economical opportunities. The Wadden Sea is an area where people live, work and recreate.

3 It is only 30 years ago that there were serious plans to embank substantial parts of the Wadden Sea for agricultural purposes. Nowadays, it is a common understanding that the Wadden Sea is an area with unique natural values which are the basis for livelihood of the local people, tourism, recreation and other activities.

4 At the beginning of the 1970s, national and international policies for combatting chemical pollution of the sea started. Since then, a considerable shift in thinking occurred which resulted in substantial improvements in the quality of the water and sediment.

5 This shift in thinking started at the beginning of the century through the pioneer work of concerned citizens and non-governmental organizations who founded protected colonies for birds. Still, it has taken almost 70 years before the official awareness of the importance of the area resulted in effective nature protection. Central, regional and local governments and interest groups have played an important role here, although they have often been criticized.

6 Almost 20 years ago, a process began which resulted in the protection and conservation of the entire Wadden Sea with nature reserves and national parks and the establishment and extension of the trilateral Wadden Sea cooperation between The Netherlands, Germany and Denmark. In parallel, parts of the area were designated as Wetlands of International Importance (Ramsar Areas), Bird and Habitat Directives areas and as Man and Biosphere (MAB) Reserves.

7 The Wadden Sea is a coastal sea and there are many interactions with the North Sea and the northwestern European mainland. The quality of water, sediment and marine habitats of the Wadden Sea is to an important degree affected by the North Sea and activities in the catchment are as of the debouching rivers. The Wadden Sea is an important nursery area for North Sea fish and some species of marine mammals. For these reasons, the trilateral policy and management regarding pollution and species and habitat protection issues have been, and are, closely related

International Designations

(see maps in Appendix I)

A. Legally binding EC Directives

1. The Council Directive 79/409/EEC 1979 (EC Bird Directive) aims at the protection of all species of naturally occurring birds in the territory of the member states. According to the Bird Directive, member states shall classify the most suitable territories for the conservation of these species, including migratory species, as special protection areas (SPAs). The Dutch part of the Conservation Area[1] has been designated as SPA. In Germany, the Lower Saxony part of the Conservation Area has been designated as SPA, as well as, the islands of Scharhörn and Neuwerk and the Schleswig-Holstein Wadden Sea National Park and five adjacent areas. The designation of the Hamburg Wadden Sea National Park is under preparation.
   In Denmark, the Danish part of the Conservation Area, with the exception of the shipping lane from the North Sea to Esbjerg, the uninhabited parts of the islands and the adjacent marsh areas on the mainland have been designated as SPAs

2. The Council Directive 92/43/EEC 1992 (EC Habitat Directive) aims at the conservation of habitats of wild flora and fauna in the member states. In the framework of the Habitat Directive, a coherent ecological network, called NATURA 2000, shall be established. NATURA 2000 will consist of Special Areas of Conservation (SACs) designated according to the Habitat Directive, and the SPAs of the Bird Directive. The designation of SACs will be undertaken in the forthcoming years and major parts of the Wadden Sea will be included in NATURA 2000.

B. International Conventions and Programs

3. The Convention on Wetlands of International Importance Especially as Waterfowl Habitat 1971 (Ramsar Convention) is a world wide treaty for the conservation of wetlands: shallow open waters and any land regularly or intermittently covered or saturated by water. In the framework of the Convention, wetlands of international importance are designated by the contracting parties. Major parts of the Wadden Sea have been designated as Ramsar sites: The Dutch part of the Conservation Area is a Ramsar site. In Germany, the Wadden Sea Ramsar sites are basically the national parks and a number of areas on the islands and the adjacent mainland. In Denmark, the Wadden Sea Ramsar site consist of the uninhabited parts of islands, adjacent marsh areas on the mainland and the Danish part of the Conservation Area, except for the shipping lane from the North Sea to Esbjerg and the Esbjerg harbor.

4. Man and Biosphere Reserves (MAB) are protected areas of representative terrestrial and coastal environments which have been internationally recognized under the United Nations Educational, Scientific and Cultural Organization (UNESCO) MAB Program for their value in conservation and in providing the scientific knowledge, skills and human values to support sustainable economical development. The German and the Dutch parts of the Conservation Area have been designated as Man and Biosphere Reserves.

[1]The Conservation Area consists of the trilateral areas of conservation as defined in §10 of the Leeuwarden Declaration

to developments within the framework of the North Sea Conferences, the Oslo and Paris Conventions and, in their succession, the Convention for the Protection of the Marine Environment of the northeast Atlantic (OSPAR Convention 1992), which is expected to be ratified in the near future, and the International Maritime Organization (IMO).

8 Through these national and international designations and treaties, the Wadden Sea has obtained an extended and comprehensive protection status. The protection schemes and arrangements resulting from these designations, can be regarded as a start of the implementation of the commitments emerging from the Convention on Biological Diversity and Agenda 21. They are also the basis for the present and future sustainable use and development of the Wadden Sea region.

9 It is often argued nowadays that "we have done enough for nature" and even that the Wadden Sea is overprotected. The many rules and regulations, however, directly reflect the many claims to use the Wadden Sea. These claims are often as relevant as a decade ago and, in a number of cases, even more serious. Land reclamation will not be carried out again and the reduction of pollution is a highly relevant political issue but intensified impacts and conflicts may be expected from, amongst others, gas exploration and exploitation, wind energy, deepening of estuaries and coastal protection, in light of the increased sea level rise.

10 Moreover, we are dealing with a system which reflects past impacts. Land reclamation, for example, has reduced the size of the area which again has reduced the ability of the system to deal with an accelerated sea level rise. The occurrence of black spots in the Lower Saxony Wadden Sea is an indication of accumulated organic material resulting from eutrophication. Also, the high number of threatened habitats, as indicated in red lists, must be reduced to achieve the full scale of habitat types which belong to a natural and dynamic Wadden Sea.

11 The Targets, which are the focal point of this document, reflect both the need for a recovery of the natural values of the Wadden Sea ecosystem and the necessity that human activities in the area must also be possible in the future. The Targets make clear that an increase of natural and undisturbed habitats all over the Wadden Sea is a condition for the restoration of the ecosystem. The Targets have been formulated in an open-end way, although the direction towards the desired situation is given. This means that there is room for negotiation, both from the user and the nature protection sides.

12 At the same time, it is a precondition that sustainable human activities in the area remain possible in the future. Sustainable development also has to take into account the needs and requirements of the population, e.g. coastal protection measures, management of shipping routes, energy supply, agriculture, fishery, tourism, infrastructure and internal and external security.

13 Through this Plan, inhabitants, users, visitors and all stakeholders in the Wadden Sea region are invited to provide their ideas and inputs to the implementation of the Targets.

The Shared vision

14 The Targets feature a shared vision of the Wadden Sea which encompasses the countries' aspirations:

- A healthy environment which maintains the diversity of habitats and species, its ecological integrity and resilience as a global responsibility.

- Sustainable use.
- Maintenance and enhancement of values of ecological, economic, historic-cultural, social and coastal protection character, providing aspirations and enjoyment for the inhabitants and users.
- Integrated management of human activities which takes into account the socio-economic and ecological relationship between the Wadden Sea Area and the adjacent areas.
- An informed, involved and committed community.

I. Integrated Management of the Wadden Sea

The Wadden Sea Plan

1 At the 6th Trilateral Governmental Conference in Esbjerg in 1991, it was decided to elaborate a management plan covering the Wadden Sea from Den Helder to Esbjerg in order to further substantiate the joint coherent protection. At the Esbjerg Conference, and the subsequent conference in 1994, the Leeuwarden Conference, the cornerstones of the Wadden Sea Plan were adopted: the delimitation of the Trilateral Area of Cooperation and Conservation, the Guiding Principle, the Management Principles, and the Targets.

2 A precondition is, that all measures, activities and policies mentioned in this plan, are to be realized in a sustainable way, as defined in the Convention on Biological Diversity. The three parties stress that this definition implies that the use of components of biological diversity may not lead to the long-term decline of biological and ecological diversity and that nature protection may not lead to the long-term decline in socio-economic conditions for the inhabitants of the Wadden Sea Area. The interests of all user groups within the Wadden Sea Area must be weighed against general and specific protection aims in a proper way. The impairment of traditional interests of the local population, which are not contrary to the protection aims, should be avoided.

3 The implementation of the Plan will not affect the protection of the local inhabitants against the sea.

Status

4 The Wadden Sea Plan entails policies, measures, projects and actions which have been agreed upon by the three countries. The Plan is a framework for the overall Wadden Sea management and will be revised at regular intervals. It is a statement on how the three countries envisage the future coordinated and integrated management of the Wadden Sea Area and the projects and actions that must be carried out to achieve the Targets.

5 The Wadden Sea Plan was developed with the participation of authorities and interest groups. The Plan was prepared with financial support from the European Commission.

6 The Plan is a political agreement[2] and will be implemented by the three countries in cooperation, and individually, by the competent authorities on the basis of existing legislation and through the participation of interest groups. The implementation of the Plan shall not interfere with legislation regarding, in particular, marine navigation, management of marine navigation

[2] Meaning it is a legally non-binding document of common political interest.

routes, harbor management, disaster control, sea rescue services and other aspects of internal and external security.

Delimitation

7 The geographical range of the Wadden Sea Plan is the Trilateral Wadden Sea Cooperation Area, in short, Wadden Sea Area, which is

- the area seaward of the main dike, or where the main dike is absent, the spring-high-tide-water line, and in the rivers, the brackish-water limit;
- an offshore zone 3 nautical miles from the baseline;
- the corresponding inland areas to the designated Ramsar and/or EC Bird Directive areas;
- the islands.

The trilateral conservation area , in short the Conservation Area, is situated within the Wadden Sea Area, and consists of:

- in The Netherlands, the areas under the Wadden Sea Memorandum including the Dollard;
- in Germany, the Wadden Sea national parks and protected areas under the existing Nature Conservation Act seaward of the main dike and the brackish water limit including the Dollard;
- in Denmark, the Wildlife and Nature Reserve Wadden Sea.

A map of the Wadden Sea Area and the Conservation Area is given in Appendix I.
It is recognized that within the Wadden Sea Area, there are areas in which human use has the priority.

Shared Principles

8 The Guiding Principle of the trilateral Wadden Sea policy is "to achieve, as far as possible, a natural and sustainable ecosystem in which natural processes proceed in an undisturbed way" (ED §1). The Principle is directed towards the protection of the tidal area, salt marshes, beaches and dunes (LD §8).

In addition, seven Management Principles have been adopted which are fundamental to decisions concerning the protection and management within the Wadden Sea Area (Esbjerg Declaration §3):

- the Principle of Careful Decision Making, i.e. to take decisions on the basis of the best available information;
- the Principle of Avoidance, i.e. activities which are potentially damaging to the Wadden Sea should be avoided;
- the Precautionary Principle, i.e. to take action to avoid activities which are assumed to have significant damaging impact on the environment, even where there is no sufficient scientific evidence to prove a causal link between activities and their impact;
- the Principle of Translocation, i.e. to translocate activities which are harmful to the Wadden Sea environment to areas where they will cause less environmental impact;
- the Principle of Compensation, i.e. that the harmful effect of activities which cannot be avoided, must be balanced by compensatory measures; in those parts of the Wadden Sea, where the Principle has not yet been implemented, compensatory measures will be aimed for;
- the Principle of Restoration, i.e. that, where possible, parts of the Wadden Sea should be restored if it can be demonstrated by reference studies that the actual situation is not optimal, and that the original state is likely to be re-established;
- the Principles of Best Available Techniques and Best Environmental Practice, as defined by the Paris Commission.

Unreasonable impairments of the interests of the local population and its traditional uses in the Wadden Sea Area have to be avoided. Any user interests have to be weighed on a fair and equitable basis in the light of the purpose of protection in general, and the particular case concerned .

Targets

9 The trilateral conservation policy and management is directed towards achieving the full scale of habitat types which belong to a natural and dynamic Wadden Sea. Each of these habitats needs a certain quality (natural dynamics, absence of disturbance, absence of pollution), which can be reached by proper conservation and management. The quality of the habitats shall be maintained or improved by working towards achieving Targets which have been agreed upon for six habitat types. Targets on the quality of water and sediment are valid for all habitats. Supplementary Targets on birds and marine mammals have been adopted, as well as, Targets on landscape and cultural aspects.

Zoning

10 In a large complex ecosystem like the Wadden Sea, a differentiated management is necessary to balance the implementation of the Targets and sustainable human use.
At the Leeuwarden Conference, it was agreed 'to acknowledge zoning as a valuable management instrument and consider the need for harmonization of this and other management instruments' (LD §18.5).

11 The three Wadden Sea countries use different approaches to zoning. In order to be able to compare the implementation of the Targets in the different parts of the Wadden Sea Area, a common understanding of the various protection regimes and the way they are applied in the three countries is necessary. To this end, the different national protection regimes will be compared and assessed on the basis of a common classification tool. On the basis of this assessment, the need for harmonization of zoning, in relation to other instruments, will be investigated.

Economic development and potentials

12 Within the constraints of a suitable protection and a natural development of the Wadden Sea, economic activities remain possible. Agriculture, industry, shipping, fisheries, tourism and recreation have considerable economic significance for the Wadden Sea region and must be balanced in a harmonious relationship between the needs of society and ecological integrity. This will be done in cooperation with the stakeholders. Regarding sustainable tourism development and recreational use in the Wadden Sea region, a joint proposal will be elaborated, together with the Interregional Wadden Sea Cooperation, for a policy emphasizing the development of communication and the involvement of the stakeholders. The policy should aim at contributing to maintain the social structures and cultural identity of the region.

Communication and information

13 The Targets are the focal point of this plan. In order to achieve the goal to protect the full scale of habitat types in the Wadden Sea Area and a successful implementation of the Wadden Sea Plan, the active support of relevant authorities, interests groups and local citizens is important.

14 Effective communication on this plan and Targets are essential and possibilities to enhance this and improve public participation will be explored. Notwithstanding the responsibility of competent authorities for the conservation and protection of the Wadden Sea Area, different types of active involvement of stakeholders (co-management) can contribute to many aspects of the implementation of the Wadden Sea plan.

15 The following trilateral projects and actions will be undertaken:
- The possibilities for enhancing the quality of public participation, amongst others, by different types of active involvement of stakeholders (co-management) will be explored on a national basis.
- The results of the Trilateral Monitoring and Assessment Program (TMAP) will be made available for relevant authorities, interest groups and local citizens.
- The possibilities for a trilateral information and communication site on the Internet will be explored.

16 The competent authorities are invited to submit information on Environmental Impact Assessments in the Wadden Sea region to the Common Wadden Sea Secretariat.

Evaluation and review

17 The progress of the implementation of the trilateral policies and management, projects and actions entailed in the Wadden Sea Plan will be evaluated in preparation of each Trilateral Wadden Sea Conference on the basis of, inter alia, the Quality Status Reports on the Wadden Sea (QSRs) emerging from trilateral monitoring and assessment activities, relevant reports and developments on the national and international level. As appropriate, the Wadden Sea Plan will be amended on the basis of the conclusions and recommendations of the review process.

Structure of the Plan

18 This document is structured according to the Target categories as adopted at the Leeuwarden Conference:

- Landscape and Culture
- Water and Sediment
- Salt Marshes
- Tidal Area
- Beaches and Dunes
- Estuaries
- Offshore Area
- Rural Area
- Birds
- Marine Mammals

For each Target category, a brief description is given followed by its current status, the precise wording of the relevant Target(s), an assessment of the situation and how to proceed. On the basis hereof, trilateral policy and management and proposals for trilateral projects and actions necessary for the implementation of the Targets have been developed, taking into account the Esbjerg and Leeuwarden Declarations.

The measures, projects and actions generally apply only to the habitat under consideration. The chapters 'Landscape and Culture', 'Water and Sediment', 'Birds' and 'Marine Mammals' have a habitat crossing character. Measures, projects and actions contained in these chapters also apply to one or more of the other habitats.
Three Appendices are attached to the Plan. In Appendix I, thematic maps of the Wadden Sea Area are given. Appendix II contains an index of entries of activities, Appendix III a glossary.

II. The Targets

1 Landscape and Culture

2 Water and Sediment

3 Salt Marshes

4 Tidal Area

5 Beaches and Dunes

6 Esturaries

7 Offshore Area

8 Rural Area

9 Birds

10 Marine Mammals

1 Landscape and Culture

About 2,600 years ago, salt marshes started to develop behind the Wadden Sea islands. The green, fertile grounds, which are, nowadays, the embanked polders and marsh areas of the northern Netherlands, northern Germany and the most southern part of Denmark, were soon to be inhabited and cultivated.

The contemporary towns and villages are in many cases located at the authentic settlements on the small artificial mounds which were erected by the earliest settlers from the 7th century B.C. onwards. Nowadays, they belong to the most characteristic elements of the Wadden Sea marsh landscape. The earliest inhabitants lived in an area of tidal flats, moors and swamps. The mounds constituted the only active interference in the area.

About 1,000 A.D., the building of a comprehensive system of seawalls and sluices commenced, in order to enable further grazing and agricultural use. It allowed for settling in the marshes without the use of artificial mounds. Through the subsequent centuries, a unique and wide-open landscape developed with extensive agricultural activities with, a.o., cattle breeding and an industrious commerce with a large part of Europe.

In conjunction with agriculture, North Sea fishery, trade and whaling, a flourishing economy developed in extensive periods throughout the centuries on the islands and the polder and marsh areas which laid the foundation for the development of urban centers and villages and which, in terms of buildings and houses, are quite characteristic, well conserved and unique.

Of international interest is, also, the role the Wadden Sea played in international shipping. Through the ages, important routes went through the Wadden Sea. A prominent record of this history are the numerous ship wrecks in the Wadden Sea.

Status

The topography of the contemporary landscape is, to a large degree, determined by the way it was shaped by Man. The ditches and the cultivated landscape still follow the natural creek and lagoon system of the salt marshes. The roads are situated along the shores and the higher parts of the marshes and polders and the contour of the seawall determines the horizon. The Wadden Sea landscape is characterized as wide open, with the seawall as the delimitation between the dynamic processes of the tidal flats and salt marshes and the cultural landscape of the marshes and polders.

The cultural-historic and landscape values of the area are intimately related to the economic and social development of the coastal area and, by international standard, unique and unrivalled. The cultural historic and landscape values are equivalent to the area's natural values and are an important basis for the development of tourism.

The cultural-historic and landscape heritage and the diversity between the regions are essential for the comprehension of the area's development and identity and the inhabitants' identification with the landscape. It entails a distinctive international dimension comparable to its natural values. Therefore, it was agreed at the Leeuwarden Conference in 1994 to pay attention to this aspect as the third dimension in the trilateral Wadden Sea cooperation, in addition to the natural and environmental dimensions. The integration of all three dimensions into a coherent policy and management is essential to ensure a sustainable development.

Targets

Identity - to preserve, restore and develop the elements that contribute to the character, or identity, of the landscape.

Variety - to maintain the full variety of cultural landscapes, typical for the Wadden Sea landscape.

History - to conserve the cultural-historic heritage.

Scenery - to pay special attention to the environmental perception of the landscape and the cultural-historic contributions in the context of management and planning.

Assessment

The landscape and cultural-historic heritage of the Wadden Sea Area is under rapid transformation because of changes in agricultural practices, amongst others, changes in crops, enlargement of land parcels, urbanization and industrialization, and the associated construction of infra-structural installations. This development interferes with characteristic elements such as the openness, serenity and identity of the landscape, the topography of the landscape and the cultural-historic remnants.
The construction of wind turbines has increased significantly during recent years because the production of electricity from wind energy is particularly productive in the area. However, wind turbine installations also interfere with the landscape values.

The historic elements of the area are, to a lesser degree, under transformation, although, at the end of the last century and the start of this century, some of the historic elements of the area partly disappeared, e.g. the old dikes and mounds which were partly excavated for fertilizer.

How to proceed

Because historic elements of the landscape and buildings are, to a considerable extent, protected by national legislation, the existing legal, administrative and planning instruments in the three countries should enable an integrated maintenance and development of the landscape, including proper planning of wind turbines. At the same time, the awareness of the unique cultural-historic and landscape values must be enhanced because it is important for the comprehension of, and the identity with, the landscape and cultural-historic values. The promotion of sustainable

cultural tourism may contribute to both enhancing the awareness of the said values and provide opportunities.

1.1 Trilateral policy and management

1.1.1 The nomination of the Wadden Sea Area, or parts thereof, as a World Heritage Site will be strived for, taking into account the natural and cultural-historic values of the area.

1.1.2 The cultural-historic and landscape elements of the Wadden Sea Area will be protected and conserved through appropriate planning and management.

1.1.3 The awareness of the area's cultural-historic and landscape values will be enhanced, where possible and appropriate, on a joint basis.

1.1.4 The construction of wind turbines in the Conservation Area is prohibited. (Identical with 9.1.9).

1.1.5 The construction of wind turbines, in the Wadden Sea Area outside the Conservation Area, is only allowed if important ecological and landscape values are not negatively affected. (Identical with 9.1.10).

1.2 Trilateral projects and actions

1.2.1 The preparation of a nomination of the Wadden Sea Area, or parts thereof, as a World Heritage Site (WHS) in close cooperation with the local and regional authorities, as well as, local interest groups and local citizens, taking into account i.a. the recommendations of the 1997 workshop on cultural-historical and landscape values.

1.2.2 An inventory and a map of the most important cultural-historical and landscape elements of the Wadden Sea area including
- an assessment of which elements should be maintained and developed and
- recommendations for the protection, taking into account the recommendations of the 1997 workshop on cultural-historical and landscape values.

The result of the investigation will be published in a report in each of the three languages to ensure that the information is easily accessible and will be widely dispersed.

1.2.3 An investigation on how the cultural and landscape features can be taken into account in Environmental Impact Assessments and an exchange of information on this.

1.2.4 An investigation of the possibilities of an initiative in the field of cultural tourism, in close cooperation with local authorities and relevant organizations.

2 Water and Sediment

The Wadden Sea is an open system. With the rising tide, marine water and sediment from the North Sea enter the Wadden Sea. Fresh water and sediments are discharged by a number of large rivers. The quality of water and sediment in the Wadden Sea is mainly determined by these external sources through which polluting substances enter the Wadden Sea. Atmospheric deposition is an additional source of pollution.

Pollutants are generally divided into three types, namely 'natural micro-pollutants', 'man-made micro-pollutants' and 'macro-pollutants'. The first class contains substances like heavy metals, which are not only produced by Man, but which also occur naturally in the environment, be it in low concentrations.
The second class, the man-made substances, also called xenobiotics, contains substances like PCBs and pesticides.
Macro-pollutants are substances which are of natural origin and can be found in relatively high concentrations in the (marine) environment. The most important ones are nutrients, in particular, phosphorus and nitrogen compounds.
Micro-pollutants can have toxic effects on biota, for example, through interference with the reproductive system or the immune system. These effects can be aggravated through bio-accumulation and synergism.
Nutrients in excess concentrations and quantities may lead to increased primary production which, in turn, can cause negative effects like oxygen depletion as a result of decaying algal material, shifts in species composition and remobilization of micro-pollutants.

Status

The relatively high level of pollution of the Wadden Sea is caused by three main factors:

- A number of rivers, of which the catchment areas are highly industrialized and agronomized, flow into the Wadden Sea. The catchment areas add up to some 231,000 km^2 which is about 17 times the Wadden Sea Area. It extends to the southeast as far as the Chechian-Austrian border. Among the rivers are the Elbe, Weser, Ems and the IJssel, a branch of the Rhine. In addition, a substantial part of the Rhine water enters the Wadden Sea via the North Sea through a coastal flow along the Dutch coast.
  Rivers are by far the largest carrier of polluting substances from the land to the Wadden Sea. The German rivers Elbe, Weser and Ems, together with the Dutch IJsselmeer, each year discharge, on average, 60 km^3 of polluted water into the Wadden Sea. The rivers transport heavy metals, PCBs and pesticides like lindane and large amounts of nutrients.

- Due to the net North Sea current, a substantial part of North Sea water and suspended particles - and consequently polluting substances - enter the Wadden Sea.

- The Wadden Sea lies at the rim of northwestern Europe. A significant part of its pollution is caused by atmospheric deposition which originates from the highly industrialized northwestern and central European countries.

Targets

Background concentrations of natural micropollutants.

Concentrations of man-made substances as resulting from zero discharges.

A Wadden Sea which can be regarded as a eutrophication non-problem area.

Assessment

Over the last two decades, the loads of toxic compounds discharged by rivers have decreased substantially. In the Wadden Sea itself, a general reduction in the concentration of regularly monitored pollutants, such as heavy metals and PCBs, can be observed.

The two most important nutrients are nitrogen compounds and phosphate. Of these, the concentrations of phosphate and, to a lesser extent, nitrogen compounds in the water of the Wadden Sea have started to decrease in the second half of the 1980s, mainly as a result of the use of phosphate free detergent and water purification.
The fact that nitrogen inputs have not been reduced as much as phosphorus, has caused a shift in the relative concentrations of these nutrients. This may cause an increase in occurrence of toxic algae. It is not clear whether there are other biological consequences.

Many toxic compounds, such as heavy metals and PCBs, entering the Wadden Sea finally end up in the sediment, especially in fine-grained sediments. During dredging, special attention has to be paid to the pollution level of the dredged spoil. Moreover, dredging and dumping of dredged material may affect the visibility of the water column.

Shipping activities are a potential source of contamination with oil, garbage and hazardous substances. In the past years, several incidents have occurred of washed ashore chemicals and oil which originated from ships. The number of oiled birds washed ashore along the Wadden Sea coast remains high. In most cases, the oil originates from shipping.
Atmospheric deposition is another major source of pollutant inputs of certain substances.

Recently, it was decided, within the IMO, that certain classes of ships carrying dangerous cargos should follow the mandatory route off the Wadden Sea coast of The Netherlands and Germany. It is the route from North Hinder to the German Bight and vice versa (Deepwater route) and it is mandatory for oil tankers larger than 10,000 gross tons (GT) and ships carrying noxious liquid substances or gases in bulk ($\geq$ 5,000 or $\geq$ 10,000 tons GT).
According to an EC Directive, vessels carrying hazardous goods entering European harbors are obligated to report to the competent authorities.

How to proceed

The trilateral policy and management, regarding pollution issues, is closely related to developments within the framework of the North Sea Conferences, the Oslo and Paris Conventions, the International Maritime Organization (IMO) and the European Union. It is within these frameworks that international agreements on pollution issues, relevant for the whole catchment area of the Wadden Sea Area, are made. The most relevant agreements are those of the North Sea Conferences and of the Paris Commission regarding a 50% reduction of nutrient inputs and a 50 to 70% reduction of inputs of hazardous substances between 1985 - 1995. In 1992, the Paris Commission decided to reduce, by the year 2000, pollution from discharges of compounds which are toxic, persistent and liable to bioaccumulate, to levels that are not harmful to man or nature, with the aim of their elimination. In 1995, the North Sea states agreed to prevent pollution by continuously reducing discharges, emissions and losses of hazardous substances, thereby, moving towards the target of their cessation within one generation (25 years); with the ultimate aim of concentrations in the environment near background values for naturally occurring substances, and close to zero for man-made synthetic substances (NSC Esbjerg, §17). Also, the MARPOL Convention is very important for the Wadden Sea because it regulates operational discharges of oil, garbage and hazardous substances from ships. In the IMO framework, furthermore, extensive regulations for the enhancement of safe ship traffic have been developed.

At the 7th Trilateral Wadden Sea Conference, it was agreed that regarding the Targets on the quality of water and sediment, it is the trilateral policy to strengthen the cooperation in relevant international frameworks to realize the Targets to reduce environmental pollution (LD §6.3). Where appropriate, such cooperation will be strengthened with the aim of further reducing, in particular, inputs of organic micro-pollutants and nitrogen.

Common Trilateral Statements were submitted to the North Sea Conferences in which the special interests and problems of the Wadden Sea have been elaborated in relation to the issues dealt with at the subsequent conferences. The coordination with the ongoing preparation of the North Sea Conferences and, regarding monitoring and assessment in OSPAR, is achieved by means of a permanent observership in the relevant working groups.

It is unclear to what extent the handling of dredging and the dumping of dredged material is comparable in the three Wadden Sea countries. In 1993, Guidelines on dredged material were published by the Oslo Commission. At the Esbjerg Wadden Sea Conference, it was agreed to cooperate in developing national criteria for dredging and disposal of dredged material in accordance with the Oslo Guidelines and to consider the need for harmonization (ED §9).
In light of the importance of dredging and dumping activities for the Wadden Sea ecosystem, it seems appropriate to evaluate this decision with the aim of continuing the process of trilateral harmonization.
With regard to illegal discharges from ships, relevant developments in the North Sea Conference and IMO frameworks must be supported. At the Leeuwarden Conference, it was decided to invite competent authorities to take appropriate steps to minimize discharges into the sea, especially from recreational shipping, including systems for the operations of shore reception facilities as soon as possible, at the latest by 1996 (LD §64.4). In order to be able to evaluate this decision, it is necessary to have an overview of the availability and accessibility of shore reception facilities in Wadden Sea ports.

2.1 Trilateral policy and management

2.1.1 Trilateral policies for the reduction of inputs of nutrients and hazardous substances from all sources are congruent with those within the OSPAR and North Sea Conference frameworks.

2.1.2 In order to reduce nutrient inputs to the Wadden Sea, the measures for sensitive areas under the Urban Waste Water Directive and the measures for vulnerable zones under the conditions of the Nitrate Directive will be applied to the catchment area of the Wadden Sea in line with the Esbjerg North Sea Conference decision.

Pollution from ships

2.1.3 With the aim of eliminating operational pollution and minimizing accidental pollution, an information and guiding system for ships carrying hazardous substances will be established.

2.1.4 Harbors bordering the Wadden Sea will have adequate facilities to handle all types of residues and wastes generated by ships to meet the requirements of the MARPOL Convention.

2.1.5 To prevent spills of oil and hazardous substances to the aquatic environment and wildlife, activities aiming at improving enforcement (surveillance and prosecution) of agreed regulations and policies to combat illegal discharges will be continued.

Dredging and dumping of dredged material

2.1.6 The three countries will develop and apply national criteria with regard to dredging operations and disposal of dredged material. They will cooperate within the framework of existing international agreements and organizations by exchanging information about the main experiences with the implementation of these criteria.

2.1.7 Dredged material from the Wadden Sea Area and Wadden Sea harbors will, in principle, be dumped back into the system unless the contamination exceeds national criteria levels.

Discharges from oil and gas exploration and exploitation activities

2.1.8 The exploration and exploitation of the energy resources in the North Sea, as well as in the Wadden Sea Area, has to comply, at least, with the international agreements in the appropriate fora. This results i.a. in a prohibition to discharge oil-based muds and cuttings. Dumping or discharge of water based muds and/or cuttings is only allowed in line with relevant PARCOM agreements.

2.1.9 The leaching of toxic substances from protective coatings of pipelines and other installations will be avoided by the use of appropriate materials.

2.1.10 In the Conservation Area, offshore activities that have an adverse impact on the Wadden Sea environment will be limited and zero-discharges will be applied. In the Wadden Sea Area outside the Conservation Area, discharges of water-based muds and cuttings will be reduced as far as possible, by applying Best Available Techniques and by prohibiting the discharge of production water from production platforms.

2.2 Trilateral policy and management

2.2.1 The development of common Wadden Sea specific criteria for the differentiation between eutrophication problem- and non-problem areas necessary for assessing progress in the implementation of the Targets for the reduction of nutrients and, consequently, the reduction of eutrophication. The project will be carried out in close cooperation with the work going on in OSPAR regarding the development of a strategy to combat eutrophication.

2.2.2 An inventory and evaluation on information and guiding systems for ships carrying hazardous substances.

2.2.3 An inventory and evaluation of national practices regarding dredging and the dumping of dredge spoils with the aim of investigating whether harmonization is necessary and feasible.

2.2.4 An inventory and assessment of the availability and accessibility of shore reception facilities.

3 Salt Marshes

The habitat type salt marsh includes all mainland and island salt marshes, including the pioneer zone. The brackish marshes in the estuaries are also considered part of this habitat type (Leeuwarden Declaration Annex I).

Salt marshes are typical Wadden Sea habitats of great beauty, diversity and attractiveness for visitors to the Wadden Sea area and they are important and unique habitats.
NATURALLY DEVELOPED SALT MARSHES have a drainage system of irregular, winding gullies, sometimes a pioneer zone, and - in the course of time - formations of salt marsh cliffs between older parts on the one side, and pioneer zones on the bordering tidal flats on the other. The remains of the natural salt marshes can be found on the landside of dune areas, and in some places, along the mainland coast.
ARTIFICIAL SALT MARSHES are salt marshes which have developed through active human interference, like shelter, by means of brush wood groynes. They are mainly situated in places where natural developments would not have led to salt marsh formation.
SUMMER POLDERS are embanked parts of the salt marshes with dikes that are high enough to prevent flooding during the growing season. The frequency of inundation varies between only once per 2 or 3 years to several times per year, depending on the height of the dikes. Remains of natural gullies and salt marsh cliffs can sometimes be found. When inundation takes place during winter, the influence of the sea water on the vegetation is often negligible. The soil is saturated with fresh water and the sea water is drained off very rapidly within a few days after flooding.

Status

The present salt marsh area is, mainly as a result of embankments, much smaller than it used to be. Moreover, many of the remaining salt marshes are heavily influenced by human use. With the exception of some locations in Denmark and Lower Saxony, almost all natural mainland salt marshes have been embanked in the past, some only as a summer polder, but most of them as polders on the land side of a sea dike. Salt marshes and summer dikes are important elements of the coastal protection strategy.
Most of the artificial salt marshes on the Wadden Sea islands have an almost natural geomorphology, whereas most mainland artificial salt marshes have a geomorphology that is dominated by human structures: brushwood groynes, ditches and ground dams.
The artificial salt marshes are considered an additional advantage resulting from embankments, although created at the expense of natural tidal areas.

Targets

An increased area of natural salt marshes.

An increased natural morphology and dynamics, including natural drainage patterns of artificial salt marshes, under the condition that the present surface area is not reduced.

an improved natural vegetation structure, including the pioneer zone, of artificial salt marshes.

Favorable conditions for migrating and breeding birds.

Assessment

Large areas of natural and artificial salt marshes have been embanked in the past. This has not only caused a considerable loss of this typical Wadden Sea habitat, but also reduced the volume of the tidal basin considerably. These losses have been compensated for, at least partly, on the islands where new salt marshes developed in the shelter of sand dikes and on the mainland through the stimulation of sedimentation. Most of the island salt marshes have developed in a natural way, whereas the mainland salt marshes must be regarded as largely artificial.

The main interference with the natural development of salt marshes and summer polders is caused by coastal protection and land reclamation activities. The intensive drainage of the 'normal' management practice of the land reclamation areas is, at least partly, beneficial for agriculture.
Agricultural activities, mainly grazing and drainage, but also the application of fertilizer and pesticides, affect the natural vegetation structure and, consequently, the faunal composition.

The effects of a reduction of the volume of the tidal basin, in the light of sea level rise and bottom subsidence, are not quite well understood. There is, however, the danger that these combined processes will cause a reduction of the area of tidal flats.There are indications that this might result in some areas in the reduction of the area of the salt marshes.

How to proceed

The possibilities for the development of new natural salt marshes are restricted. The best way to increase the area of natural salt marshes is through improving natural conditions in existing salt marshes. The natural morphology and dynamics of the salt marshes must be enhanced through reduction of interference with natural processes. For example, artificial drainage systems should be modified in such a way that they become self sustaining. In order to improve the natural vegetation structure and the conditions for birds, the grazing pressure must, where necessary, be reduced.
Disturbance of birds through hunting and recreational activities should be reduced as much as possible.
Outbankment of summer polders, excluding the summer dikes of the Halligen, because these protect the inhabitants, is a very good instrument to enlarge the salt marsh region, provided

socio-economic and coastal protection aspects are considered as well. It can yield salt marsh areas without interference with natural geomorphological processes. Ecologically valuable habitats can be restored, in case of summer polders, on relatively old and high salt marshes. Such salt marshes are rare and their restoration is of utmost importance for the restoration of the total richness of the mainland salt marsh habitats.

3.1 Trilateral policy and management

3.1.1 The general trilateral policy regarding salt marshes aims at adequately protecting salt marshes in order to allow natural processes to take place within this habitat, with special emphasis on flora and fauna. To this end, all salt marshes shall be brought under legal protection, insofar this has not yet been done, and Best Environmental Practice will be applied in salt marsh protection and development, taking account of experiences with local concepts and measures.

Salt Marsh Area

3.1.2 The trilateral policy takes as starting point that the present area of salt marshes will not be reduced and that, where possible, the area of natural salt marshes will be extended.

3.1.3 The long-term goal is to limit human interference with the salt marshes, except for the edges of the marshes which may need protection against erosion. In working towards this long-term goal, the interest of cultural history, coastal protection and private rights should be taken into account.

3.1.4 The present artificial salt marsh area can be protected against erosion because the size of the land reclamation salt marshes along the mainland is, generally, still far below the total size of the mainland salt marshes in a more natural situation without sea walls.

3.1.5 An increase of the salt marsh area will be aimed for through the restoration of salt marshes by opening summer dikes, provided that it is in line with the Targets for the region, socio-economic conditions and coastal protection requirements. The Halligen are protected by summer dikes for the security of the inhabitants. There is no intention to open these dikes.

Coastal Protection

3.1.6 The interests of nature protection and sea defence measures will be further harmonized, taking into account that the safety of the inhabitants is essential.

3.1.7 As a principle, it is prohibited to embank salt marshes and loss of biotopes through sea defence measures will be minimized. Reinforcement of existing dikes will be carried out on the location of existing dikes and, preferably, on the land side. (Reference to 4.1.2).

3.1.8 The application of Best Environmental Practices for coastal protection will be enhanced.

3.1.9 In general, clay for sea defence will be extracted behind the dikes. In special cases, i.e. where there is urgent and sudden need and if no other deposits behind the dikes are available, or if the extraction of suitable material is ecologically balanced, the extraction of clay may be allowed in front of the dike. In this case, the extraction shall be carried out in such a way that

the environmental impact is kept to a minimum and permanent or long lasting effects are avoided and, if this is not possible, compensated.

Natural Dynamics

3.1.10 The natural drainage of salt marshes will be increased by reducing drainage works where possible and practicable and by introducing more environmentally friendly digging methods.

3.1.11 It is the aim to reduce and/or diversify grazing in order to increase the diversity of vegetation and associated animal species in salt marshes, with the exception of those areas where grazing is necessary for coastal protection measures.

3.1.12 It is the aim to reduce disturbance caused by recreation and tourism by introducing and applying information systems and/or temporal and spatial zoning. (Identical with 5.1.8).

3.1.13 The application of natural and artificial fertilizers and pesticides and other toxic substances on the salt marshes will be stopped.

Infrastructural works

3.1.14 New infrastructural works which have a permanent or long-lasting impact should not be established in salt marshes.

3.1.15 Infrastructural works which are necessary for the supply of the islands and the Halligen with, amongst others, gas, water and electricity, or other utilities, shall be carried out in a way that the environmental impact on the Wadden Sea is kept to a minimum and permanent, or long lasting, impacts are avoided. (Identical with 4.1.14).

3.1.16 New licenses for the construction of pipelines in the salt marshes for the transport of gas and oil shall not be issued unless such measures are necessary for imperative reasons of overriding public interest. In that case, the method of construction and the planning of the location line shall be such that the environmental impact on the Wadden Sea ecosystem is kept to a minimum and permanent, or long lasting, negative impacts are avoided. (Reference to 4.1.13).

3.2 Trilateral projects and actions

3.2.1 A study into the possible effects of enhanced sea level rise by a Trilateral Expert Group to be established under the coordination responsibility of the competent authorities and, on the basis of these studies, the development of proposals for future integrated coastal defence and nature protection policies. (Identical with 4.2.1, 5.2.2, 7.2.1).

3.2.2 The investigation of existing salt marsh maintenance works and methods and possibilities for enhancing more natural drainage patterns.

3.2.3 The investigation of existing agricultural use of the salt marshes and methods for improving the quality of the salt marshes.

4 Tidal Area

The tidal area covers all tidal flats and subtidal areas. The border of the North Sea side is determined by an artificial line between the tips of the islands. The borders to the estuaries are determined by the average 10‰ isohaline at high water in the winter situation (Leeuwarden Declaration Annex I).

The tidal area is the most characteristic habitat of the Wadden Sea. It is characterized by an ever changing pattern of plates and gullies. At low tide, the tidal flats cover about two thirds of the tidal area. The tidal flats of the Wadden Sea form the largest unbroken stretch of mudflats in the world.

Status

As a result of the daily tides and the open connection with the North Sea, the tidal area is a very dynamic area.
Characteristic biological features of the tidal area are, amongst others, mussel beds, *Sabellaria* reefs and *Zostera* fields. The tidal area is subject to natural impacts like ice winters, strong gales, changes in average temperature, visibility and parasites. Additionally, there is the influence of Man through, amongst others, fisheries, dredging, offshore activities and coastal protection measures.
At low tide, the tidal flats are important feeding, roosting and/or moulting areas for birds and seals. The high biological productivity of the tidal area is, also, in part, the basis for shellfish fisheries and mussel cultures.
Next to fisheries, recreation is an important activity in the tidal area; the main recreational activities are mudflat walking and boating.
Parts of the tidal areas constitute the seaward access to harbors. Management of these marine navigation routes is in the interest of the public and is regulated nationally.

Targets

A natural dynamic situation in the tidal area.

An increased area of geomorphologically and biologically undisturbed tidal flats and subtidal areas.

An increased area and a more natural distribution and development of natural mussel beds, *Sabellaria* reefs and *Zostera* fields.

Viable stocks and a natural reproduction capacity, including juvenile survival, of the Common Seal and the Grey Seal.

Favorable conditions for migrating and breeding birds.

Assessment

The natural dynamics of the tidal area have been considerably influenced by land reclamation and the construction of dikes and other coastal defence works. These have caused a substantial reduction of the volume of the tidal basin. Also, the dredging of shipping lanes, sand extraction and natural gas extraction influence the natural dynamics in the tidal area.
The tidal area is a sediment importing system and has, therefore, been able to compensate for the subsidence of the sea bottom. The sea level rise caused by the greenhouse effect will most probably increase the sediment importing demands. The exploitation of natural gas in and around the Wadden Sea area, causes an additional subsidence of the sea floor and aggravates the effects of sea level rise. The extraction of sand from the Wadden Sea for commercial purposes also has a negative effect on the sand balance. There is an important link with the offshore zone because sand is imported from this area. This will affect the sandy coast of the islands which will become steeper.
Also important for the sand balance in the Wadden Sea, is the water circulation pattern which, in turn, has been, and still is, influenced by land reclamation and coastal defence activities.
There are indications that embankments and the shortening of the coastline have decreased the amount of available fine sediments and the possibilities for the sedimentation of fine sediments.

Several human activities, especially cockle and mussel fisheries, dredging and sand and shell extraction, disturb the sediment. This may cause temporal or structural changes in the sediment morphology and biology, a reduction of sediment stability, and an increased turbidity of the water column. Mussel culture can have large effects on the habitat structure of subtidal and intertidal areas.

Disturbance may interfere with the normal behavior of animals. The actual impact depends on the level and duration of the disturbance and the period in which it occurs. Human uses which cause disturbance, and for which trilateral political agreements have been adopted, are fisheries, hunting, recreation, shipping, civil air traffic, military activities, mineral extraction and the generation of energy.

A characteristic feature of the Wadden Sea tidal area is its high biological productivity which is

the main reason for the fact that the Wadden Sea is an important nursery area for North Sea fish and for the high numbers of breeding and migrating birds which feed in the area. Shellfish fisheries may interfere with the normal food availability of certain bird species. This interference may have consequences for the food availability in years with low shellfish stocks.

In the last decade, a serious decrease in the numbers and size of mature mussel beds has occurred, mainly in the Dutch and Lower Saxony part of the Wadden Sea. Fishing for seed mussels is an important factor in this decline, but also, ice winters and storms play a role.
It is unclear what the main causes for the decline in *Sabellaria* reefs and seegrass meadows have been.

How to proceed

In the framework of the trilateral cooperation, a large number of measures to counteract the negative effects of human presence in the area and the exploitation of natural and mineral resources has been agreed upon.
In light of the expected sea level rise resulting from the greenhouse effect, additional or amended policies are desirable for the management of the tidal basin. Such policies must be carefully tuned with those concerning the dynamic situation in the offshore area, beaches and dunes, salt marshes and estuaries.
Furthermore a better management of characteristic tidal area communities, especially wild mussel beds, *Zostera* fields and *Sabellaria* reefs is necessary for a proper implementation of the relevant Targets.
The management of seals in the tidal area is covered by the Seal Management Plan. This plan will be amended and updated at regular intervals.

4.1 Trilateral policy and management

Natural dynamics and coastal protection

4.1.1 Because the natural dynamics in the tidal area are directly related to coastal defence activities on the mainland coast, the islands and the offshore zone, future coastal protection policies will, as a principle, be based on these interrelationships.

4.1.2 Embankments of tidal areas will, as a principle, be prohibited and the loss of biotopes through sea defence measures minimized. Reinforcement of existing dikes will be carried out on the location of existing dikes and, preferably, on the land side. (Reference to 3.1.7).

4.1.3 Permission for small-scale modifications of jetties, piers and other infrastructural works along the Wadden Sea coast shall only be given after a careful review of all interests.

4.1.4 Permission for new permanent structures, which may influence the natural dynamics in the tidal area of the Conservation Area, will not be granted unless for imperative reasons of overriding public interest and if no alternative can be found.
Permission for new permanent structures, which are likely to have significant effects on the natural dynamics in the tidal area outside the Conservation Area, will only be granted after having been made subject to an assessment in accordance with the EC Directive on Environmental Impact Assessment.
All construction shall be carried out in such a way that the environmental impact is kept to a

minimum and permanent, or long lasting, effects are avoided and, if this is not possible, compensated.

Shipping, harbors and industrial facilities

4.1.5 The extension, or major modification, of existing harbor and industrial facilities and new construction shall be carried out in such a way that the environmental impact is kept to a minimum and permanent, or long lasting, effects are avoided and, if this is not possible, compensated. In the Conservation Area, new not yet approved plans for new construction, as well as for the extension or major modification of existing harbor and industrial facilities, are not allowed unless such is necessary for imperative reasons of overriding public interest and if no alternative can be found. (Identical with 6.1.1).

4.1.6 Shipping routes and harbors are to be managed for their intended purposes; in doing so, negative impacts should be avoided, as far as possible.
Navigation dredging operations should aim at allowing natural processes to run their course, as far as possible.

4.1.7 New shipping routes to the harbors and the Wadden Sea islands will, in principle, not be dredged unless the present routes threaten to disappear.

4.1.8 Shipping links across the water shed[3] and other routes exist by virtue of natural dynamics. For such routes, in principle, no dredging operations will be carried out.

4.1.9 Speed limits within the tidal area have been, or will be, imposed where such is deemed necessary.

Mineral extraction and infrastructure

4.1.10 In the Conservation Area, new exploitation installations for oil and gas will not be permitted.
Exploration activities are permitted within the Conservation Area if it is reasonably plausible that deposits can be exploited from outside the Conservation Area. Net loss of nature value must be prevented. Therefore, exploration activities will be regulated in space and time. Associated studies, mitigation and compensation measures should be carried out where appropriate.

4.1.11 The extraction of sand in the Conservation Area will be limited to the dredging and maintenance of shipping lanes. This sand can be used for, inter alia, sea defence purposes. In specific cases, sand may also be extracted for sea defence purposes.
The extraction of sand in the Wadden Sea Area outside the Conservation Area should make maximum use of sand generated by the maintenance of shipping lanes. It should be carried out in such a way that the environmental impact is kept to a minimum and permanent, or long lasting, effects are avoided and, if this is not possible, compensated.

4.1.12 Permits for small scale extractions of sand will remain in force. Small scale extractions of mud and sea water for medical purposes will remain permitted.

[3] Watershed is translated in Danish into ”vandskel”, in German into ”Wattrücken” and in Dutch into ”wantij”

4.1.13 The construction and planning of pipelines shall be such that the environmental impact on the Wadden Sea ecosystem is kept to a minimum and permanent, or long lasting, negative impacts are avoided, and if this is not possible, compensated. In the Conservation Area, new licenses for the construction of pipelines in the tidal area for the transport of gas and oil shall not be issued unless such measures are necessary for imperative reasons of overriding public interest and if no alternative can be found. (Reference to 3.1.16).

4.1.14 Infrastructural works which are necessary for the supply of the islands and the Halligen with, amongst others, gas, water and electricity, or other utilities, shall be carried out in a way that the environmental impact on the Wadden Sea is kept to a minimum and permanent, or long lasting, impacts are avoided. (Identical with 3.1.15).

Dredged material

4.1.15 The impact of dumping dredged materials will be minimized. Criteria are, amongst others, appropriate dumping sites and/or dumping periods. (Identical with 6.1.3).

Mussel and cockle fishery

4.1.16 The negative effects of cockle fishery are being limited by:
- Cockle fishery is not allowed in the German part of the Conservation Area;
- Cockle fishery is not allowed in the Danish part of the Wadden Sea Area, with the exception of some small areas along the Esbjerg shipping lane and in the Ho Bay;
- Cockle fishery is allowed in the Dutch part of the Wadden Sea Area, but has been limited by the permanent closure of considerable areas; there are possibilities for additional restrictions to safeguard food for birds. A co-management scheme with the fishing industry is in operation, in which the protection and enhancement of the growth of wild mussel beds and Zostera fields are central elements. (Identical with 9.1.3).

4.1.17 The negative effects of mussel fishery are limited by the permanent closure of considerable areas. In addition, the management of fishery on mussels aims at, inter alia, protecting and enhancing the growth of wild mussel beds and Zostera fields. (Identical with 9.1.4).

4.1.18 Mussel fishery will, in principle, be limited to the subtidal area. Based on national management plans, which are documented in the Progress Report, fishery on the tidal flats may be granted. The fishery sector is called upon to exchange information on the existing practices and to investigate possibilities for minimizing impacts of mussel fishery, in general and seed mussel fishery, in particular. (Identical with 9.1.5).

4.1.19 The current area of mussel culture lots will not be enlarged.

4.1.20 The existing permit for oyster culture will remain in force for traditional reasons. According to this permit, the imported oysters originate from hatcheries and are under veterinary control. New permits will not be granted.

Tourism and recreation

4.1.21 The recreational values of the Wadden Sea will be maintained and to this end,

- in the ecologically most sensitive areas, zones have been or will be established where no recreational activities, including excursion ships and recreational boating, is allowed;
- the use of jet skis, water skis and similar motorized equipment has been, or will be, prohibited, or limited, to small designated areas;
- within the Conservation Area, new marinas will be avoided and the extension of the existing marina capacity will only be allowed within the approved levels;
- wind surfing has been, or will be, limited.

4.1.22 Speed limits for ships have been, or will be, imposed, if this is deemed necessary, taking into account safety, environmental and recreational factors.

4.1.23 The negative effects of hovercraft and hydrofoil craft and other high-speed craft are minimized by the following strategies:
- In The Netherlands and Germany, hovercraft and hydrofoil craft are forbidden in the tidal area of the Conservation Area; new, other high speed craft are forbidden outside the designated shipping routes in the area;
- In Denmark, applications for new, high-speed craft can only be granted on the basis of an Environmental Impact Assessment and if it is not in conflict with the nature protection targets for the area.

4.1.24 It is the aim to reduce disturbance caused by recreation and tourism by introducing and applying information systems and/or temporal and spatial zoning.

4.2 Trilateral projects and actions

4.2.1 A study into the possible effects of enhanced sea level rise by a Trilateral Expert Group to be established under the coordination responsibility of the competent authorities and, on the basis of these studies, the development of proposals for future integrated coastal defence and nature protection policies. (Identical with 3.2.1, 5.2.2 and 7.2.1).

4.2.2 The development of strategies for the protection and enhancement of *Zostera* and *Sabellaria* on the basis of existing and new knowledge, in view of the not yet completely understood decline of these species.

4.2.3 The investigation of possibilities and conditions for enhancing the growth of natural mussel and cockle beds*, Sabellaria* reefs and *Zostera* fields.

4.2.4 The investigation of the impact of shrimp fisheries on the bottom fauna.

4.2.5 A study into the shell production in the total system, up to three nautical miles seaward of the islands, to obtain information on natural recruitment of shells, on the basis of which new quota for sustainable shell extraction will be fixed.

4.2.6 An invitation to the Permanent Dutch-German Transboundary Waters Commission to make progress, within their mandate, in elaborating a specific action plan for the Ems Dollard estuary.

4.2.7 An inventory and evaluation of national practices regarding the dredging of shipping routes.

5 Beaches and Dunes

Beaches and dunes include beaches, primary dunes, beach plains, primary dune valleys, secondary dunes and heathland behind the dunes (Leeuwarden Declaration Annex I). Most beaches and dunes are situated on the North Sea side of the barrier islands. Mainland beaches and dunes can be found on the Skallingen and Eiderstedt peninsulas and the Husumer Bucht.

Status

Dunes and beaches have an important coastal protection function. In most parts of the Wadden Sea Area dunes are protected. The dynamics of the coastal zone have been restricted, especially in the neighborhood of inhabited areas, buildings and other artificial structures. The desire for safer, arable and inhabitable land has also led to the construction of sand dikes between neighboring dune areas or the construction of long sand dikes on the east side of islands. The result has been a considerable loss of dynamic areas and the loss of relatively rare sub-habitats, like green beach plains and primary dune valleys.
Large parts of our stable dune regions must have been overgrazed in former times, resulting in a very dynamic, but not natural, situation. This situation has changed completely. Most of the older dunes are consolidated now, partly covered by pine wood plantations, and sand transport by wind is restricted by sea defence measures. Most old dunes are erosion-free now, just being, more or less, fossil bodies with aging vegetation, without the natural renewal of secondary dune formation.

Water extraction on many of the islands has caused a lowering of the ground water table and, consequently, the disappearance of wet dune valleys with their typical vegetation. The dune vegetation is negatively affected by the input of nutrients from the air. Dunes and beaches are attractive sites for tourists. Intensive use may cause damage to the vegetation and disturbance of animals.

Targets

Increased natural dynamics of beaches, primary dunes, beach planes and primary dune valleys in connection with the offshore zone.

An increased presence of a complete natural vegetation succession.

Favorable conditions for migrating and breeding birds.

Assessment

Existing policies focus, mainly, on the protection and conservation of dunes and beaches and the harmonization of nature protection and sea defence policies. These policies have, generally, fixed the status quo. Recreational pressure, in some areas, still causes loss of natural dunes and beaches, disturbance of flora and fauna and a lowering of the ground water table through increased ground water extraction. The only two threatened breeding bird species in the Wadden Sea Area, the Kentish Plover and the Little Tern, breed on beaches.

How to proceed

In order to implement the Targets on increased natural dynamics and natural vegetation succession, a more active policy is necessary, promoting coastal protection techniques which allow for higher natural dynamics. In addition, active stimulation measures enhancing the dynamic situation on beaches and in dunes may be taken. Coastal management must be carefully tuned to natural values and natural processes.
Additional protection of beach breeding species may be achieved through relatively simple zoning measures limited in space and time. From these, also the Grey Seal, which whelps and nurses on sands, may profit.
Efforts should be made to extend the protection of dune areas in the Wadden Sea Area.

5.1 Trilateral policy and management

5.1.1 Dunes will be brought under protection, insofar as this has not yet been done and natural processes are allowed to take place within this habitat, with special emphasis on flora and fauna. To this end, Best Environmental Practice will be applied in dune protection and development.

5.1.2 The interests of nature protection and sea defence measures will be further harmonized, taking into account that the safety of the inhabitants is essential.

5.1.3 For beaches, the trilateral policy takes into account the demands of recreation and tourism, coastal protection and natural values, like high geomorphological dynamics and important breeding areas. Where possible, the natural situation should be increased by 'hands-off management'.

5.1.4 In order to prevent a further loss of dune areas, the existing infrastructure will, in principle, not be extended and new constructions will, in principle, not be allowed.

5.1.5 Coastal management should aim at a natural dynamic development taking into account the necessity to protect the security of the inhabitants on the islands and safeguarding the stability and the infrastructure of the islands.

5.1.6 The loss of biotopes by sea defence measures will be minimized.

5.1.7 In case coastal protection is carried out, Best Environmental Practice will be applied.

5.1.8 It is the aim to reduce disturbance caused by recreation and tourism by introducing and applying information systems and/or temporal and spatial zoning. (Identical with 3.1.12).

5.1.9 It is important to restore the natural dynamics. This could be done by e.g.
- allowing sand drift,
- restoring natural dune vegetation,
as far as coastal protection is not affected.

5.1.10 Ground water extraction will be managed in such a way that no negative effects on wet dune valleys occur.

5.2 Trilateral policy and management

5.2.1 The selection of potential areas where dynamic dune development is possible and the elaboration of plans for stimulating and improving a dynamic development on the basis of available information.

5.2.2 A study into the possible effects of enhanced sea level rise by a Trilateral Expert Group to be established under the coordination responsibility of the competent authorities and, on the basis of these studies, the development of proposals for future integrated coastal defence and nature protection policies. (Identical with 3.2.1, 4.2.1 and 7.2.1).

5.2.3 The encouragement of experiments with offshore sand suppletion.

5.2.4 An inventory and assessment of existing Best Environmental Practices for coastal protection.

6 Estuaries

The estuaries in the trilateral cooperation are delimited on the landward side by the mean brackish water limit, and on the seaward side by the average 10‰ isohaline at high water in the winter situation. In terms of the Wadden Sea Area, the estuarine areas are thus the areas between the 10‰, isohaline as defined at the sea side up to the mean brackish water limit of the rivers, and at the landward side of the rivers, the areas outside of the main dikes or, where the main dike is absent, the spring-high-tide-water line including the corresponding inland areas to the designated Ramsar and/or EC-Bird Directive areas.

Estuaries include the river mouths with a natural water exchange with the Wadden Sea. Such brackish areas belong to the transition zone between rivers and tidal waters. There are four such estuaries in the Wadden Sea Area with 'open access' to the Wadden Sea, namely the Varde Å in the Danish Wadden Sea Area and the Elbe, the Weser and the Ems in the German Wadden Sea Area, whereas no estuaries have been preserved in the Dutch part.

Status

The estuaries serve as a migration route for migrating fish like Houting, Salmon, Trout and Sturgeon. They are bordered by salt marshes in which Reed and Sea Club-rush can dominate large areas, instead of Sea-purslane and other salt marsh species. The flocculation of clay minerals stands for a muddy soil, with a benthic fauna that suits the needs of birds like Avocet, Redshank and Spotted Redshank. The brackish salt marsh vegetation produces more biomass than any other salt marsh, attracting large numbers of ducks and geese that feed on the vegetation and the seeds that are released during the autumn.

Brackish areas are also important inundation areas. Many of these brackish salt marshes have been reclaimed and several river outflows (especially the smaller ones) have sluices that prevent natural mixing of fresh and salt water and the establishment of transition zones. In The Netherlands, initiatives have been taken to modify sluicing regimes aiming at achieving more natural transitions between fresh and salt water.

The estuaries of the rivers Elbe, Weser and Ems constitute the seaward access routes to the major German sea ports. Management of these marine navigation routes is a matter of public interest and regulated by law. The Elbe and the Weser estuaries are among the most industrialized regions of the Wadden Sea Area.
The Varde Å estuary has morphologically remained in its natural state, but is subject to a very intensive agricultural exploitation.

Targets

Protection of valuable parts of the estuaries.

Maintaining and, as far as possible, restoring the river banks in their natural state.

Assessment

The ecological importance of the river Ems is, in comparison with the other estuaries, to be valued as high, with a good water and sediment quality. The situation has been aggravated over the last ten years i. a. with the deepening of the river and the associated ecological impacts. In spite of increasing shore protection with artificial constructions, the river foreshore is in a semi-natural state with a relatively extensive agricultural use.
The development of the Weser estuary for shipping, the embankment of river banks and harbor and industrial developments have resulted in significant alterations in morphology, hydrography, flora and fauna. One of the consequences is that the deposit of mud in the outer part of the estuary is larger than in the natural situation and also, that a cloud of dispersed material has emerged.
Dredging and embankment of the river Elbe, and the concomitant developing of industries and harbors in the area, have significantly changed the ecological system. There are only very few sites in the estuary which can be regarded as natural or undisturbed. The remaining foreshore areas are protected by artificial groins and may be defined as semi-natural foreshore areas.
The Varde Å estuary has been maintained unregulated, whereas the agricultural use of the marshes and meadows has been intensified.

How to proceed

The relevant policies for water and sediment and brackish marshes also apply to the relevant elements of the estuaries.

In considerable parts of the German estuaries, human use has the priority. Shipping routes and harbors are to be managed for their intended purposes. It is, nevertheless, necessary to maintain and restore ecological functions of the estuaries. To this end, a concept is currently being worked out for the German estuaries with the aim to examine possibilities for protection of valuable parts and maintain and, as far as possible, restore the river banks to their natural state.
In the Varde Å estuary, an extensification of the current agricultural use is the aim and a restoration project has been initiated.

Assessments of the environmental impacts of new activities, compensation and mitigation, and restoration projects are central elements in policy and management. Where necessary, the protection of valuable parts of the estuaries not yet protected must be undertaken.

The sluicing regime must be modified in some areas to obtain a more regular volume of fresh water drained off from the mainland and to ensure better opportunities for migrating fish.

6.1 Trilateral policy and management

The policies for important elements of the estuaries, i.e. the water, the salt and brackish marshes, and the rural area, have been formulated in Chapter 2, 3, 8 and 9 respectively. The relevant parts of these policies also apply to valuable parts of estuaries. It concerns here, in particular, dumping of dredged material, agriculture, hunting, fisheries, recreation and energy.

6.1.1 The extension, or major modification, of existing harbor and industrial facilities and new construction shall be carried out in such a way that the environmental impact is kept to a minimum and permanent, or long lasting, effects are avoided and, if this is not possible, compensated. In the Conservation Area, new, not yet approved plans for new construction, as well as for the extension or major modification of existing harbor and industrial facilities, are not allowed unless such is necessary for imperative reasons of overriding public interest and if no alternative can be found. (Identical with 4.1.5).

6.1.2 The deepening of shipping lanes in the estuaries will be carried out in conjunction with an overall assessment of how to compensate and mitigate the measures.

6.1.3 The impact of dumping dredged materials will be minimized. Criteria are, amongst others, appropriate dumping sites and/or dumping periods. (Identical with 4.1.15).

6.1.4 Valuable parts of the estuaries will be protected and river banks will remain and be restored in their natural state, as far as possible.

6.1.5 The transition zone between fresh and salt water should be as natural as possible.

6.2 Trilateral projects and actions

6.2.1 A joint report of existing inventories and their results to determine the valuable parts including river banks and the legal and/or administrative protection of valuable areas in the estuaries. The results will be discussed on a trilateral level, for example, to determine possibilities for restoration projects including the restoration of transition zones.

6.2.2 The results of a Dutch study into the best locations for the restoration of estuarine transition zones (potential areas: Westerwoldsche Aa, IJsselmeer, Amstelmeer, Lauwersmeer and polders) where fresh/salt water exchange takes place (pumping stations) will be evaluated, after which additional measures might be taken.

6.2.3 In Lower Saxony, a concept is currently being worked out for the German estuaries with the aim to examine possibilities for the protection of valuable parts and maintain and, as far as possible, restore the river banks to their natural state.

6.2.4 A trilateral evaluation of the results of the above mentioned studies which will be taken into consideration in the further elaboration of the Plan.

6.2.5 The initiation of a project, in close cooperation with responsible port authorities, with the aim of investigating how harbor developments and environmental protection can be reconciled.

6.2.6 The evaluation of the running reintroduction project of the Houting in Denmark and Schleswig-Holstein and the consideration of further actions in other rivers of the Wadden Sea.

6.2.7 The restoration of the Varde Å estuary through extensifying agricultural use and restoring natural hydrological conditions.

7 Offshore Area

The offshore zone ranges from the 3-sea-mile line to an artificial line connecting the outer tips of the islands. The border between the offshore zone and the beaches on the islands is determined by the average low-tide-water mark (Leeuwarden Declaration Annex I).

Status

The natural morphology of the offshore zone is closely related to the natural dynamics in the tidal area and the beaches and dunes: there is a net transport of sand from the North Sea up till the 20 m isobath, into the Wadden Sea and this transport is determined by the overall water circulation. The area is important for foraging and moulting ducks, for seals and Harbour Porpoises.

There is little experience within the trilateral cooperation with the management of the offshore area. Parts of the German national parks are situated in the offshore area. The whole of the Danish offshore part of the Wadden Sea Area has a protected status. In the Schleswig-Holstein part, oil and gas exploration and exploitation are allowed only in the concession area of the Mittelplate.
In the Danish offshore area, shell fishery on species other than mussel, cockle and shrimp, is not allowed. In those parts of the German offshore area which belong to the national parks, the extraction of sand is, in principle, not allowed. As to cockle fishery, it is not planned to grant permits. Further restrictions to human use have not been imposed.
The offshore area in The Netherlands, as a part of a zone up to the 20 m isobath, is defined as the Environmental Zone: an area for which a special level of protection is offered in order to contribute to the protection, recovery and development of the entire North Sea and Wadden Sea ecosystems.

Targets

An increased natural morphology, including the outer deltas between the islands.

A favorable food availability for birds.

Viable stocks and a natural reproduction capacity of the common seal, grey seal and harbour porpoise.

Assessment

Because the natural dynamics in the tidal area are directly related to coastal defence activities on the mainland coast, the islands and the offshore zone, future coastal protection policies should, as a principle, be based on these currently better understood interrelationships and taken into account in coastal protection management.

The extraction of sand is not, in all cases, regulated on the basis of the importance of the offshore area and, more specifically, the area up till the 20 m isobath, for the overall Wadden Sea sand balance.

The offshore zone is important for birds in periods of food shortage. Safeguarding the food situation of (diving) birds is closely connected to the shellfish fishery in the area (e.g. Spisula fishery). At the Leeuwarden Conference, it was therefore decided to investigate shellfish stocks (e.g. Spisula) and the impact of fishery on the benthic stocks outside the islands and, depending on the outcome, discuss the results on a trilateral basis with the aim of safeguarding the food stocks for birds (LD §54).
It was, furthermore, decided to investigate the possibilities of a common research project on the effects of shrimp fishery (including industrial shrimp fishery) and flatfish fishery on the bottom fauna, within the realm of national competencies, with the aim to define trilateral proposals in 1997, and to consider, depending on the outcome of the investigations, further regulations, including the possibility of closing parts of the German and the Dutch Wadden Sea (LD §51).

As has become clear from the recently finalized Joint Seal Project, Common Seals spend part of their time in a zone up to 20 km offshore. Harbour Porpoises appear in considerable numbers in the adjacent coastal part of the North Sea, especially in winter, partly in spring. The Schleswig-Holstein offshore area near Sylt seems to have become an important rearing area for Harbour Porpoises.

How to proceed

Because of the interactions between hydrological and geomorphological processes in the offshore zone, the dunes and beaches, the tidal area and the salt marshes, policies aiming at increasing the natural dynamic situation in these habitats need to be tuned carefully.

Policies for safeguarding the food situation for birds are necessary for the whole offshore area and will be developed on the basis of the results of currently running research projects.

The management of seals in the offshore area is covered by the Seal Management Plan (see Chapter 10). This plan will be amended and updated at regular intervals.

In view of the high numbers of Harbour Porpoises in the offshore area, policies aiming at stimulating this development, especially in rearing areas, will be initiated.

7.1 Trilateral policy and management

7.1.1 Future coastal protection policies will, as a principle, be based on an integrated approach to coastal defence activities on the mainland coast, the islands and the offshore zone.

7.1.2 Increased attention will be given to the role of the offshore zone in the total Wadden Sea sand balance.

7.1.3 Sand extraction will only be carried out from outside the Wadden Sea Area. Exemptions for local coastal protection measures may be granted, provided it is the Best Environmental Practice for coastal protection.

7.2 Trilateral projects and actions

7.2.1 A study into the possible effects of enhanced sea level rise by a Trilateral Expert Group to be established under the coordination responsibility of the competent authorities and, on the basis of these studies, the development of proposals for future integrated coastal defence and nature protection policies. (Identical with 3.2.1, 4.2.1, 5.2.2).

7.2.2 An investigation on shellfish stocks (e.g. Spisula) and the impact of fishery on the benthic stocks, seaward of the islands and, depending on the outcome, a discussion of the results on a trilateral basis with the aim to safeguard the food stock for birds.

8 Rural Area

The rural area includes meadows and arable land on the islands and on the mainland where there is a strong ecological relationship with the Wadden Sea (Leeuwarden Declaration Annex I).

Strong ecological relationships with the Wadden Sea can obviously be determined, if the area provides physical and biological factors essential to typical Wadden Sea species, such as some bird species. Man has influenced these areas, e.g. meadows, grassland and pasture land, by mowing and grazing by cattle, horses and sheep, as well as, by the cultivation of fields with crops such as grain, potatoes and rape. Human use has priority in major parts of the rural area.

Status

Migratory birds, such as some waders, ducks and geese species, use rural areas on the islands and on the mainland behind the dikes during their stay in the Wadden Sea area. Meadows, pasture land and arable land are utilized as roosting sites by Golden Plover, Lapwing, Ruff and Whimbrel, mainly in spring and autumn.

The herbivores Widgeon, Barnacle Goose and, to a lesser extent, Brent Goose, also use meadows and arable land as feeding areas during autumn and spring.

Furthermore, rural areas such as meadows and arable land on the islands and on the mainland behind the dikes are used as alternative high-tide roosting sites, if the roosting sites in front of the dikes are not available during too high water.

Targets

Favorable conditions for flora and fauna, especially migrating and breeding birds.

Assessment

All habitats which are used by one typical Wadden Sea bird species are linked to, and depending on, each other. All these habitats are important for the different species during various periods and are essential for the natural development of these species in the Wadden Sea. This aspect should be taken into consideration while designing a management strategy for the protection of different bird populations.

Feeding areas and appropriate roosting sites on the tidal flats or salt marshes should be available in a sufficiently close distance to the breeding sites of species (e.g. Lapwing, Oystercatcher, Black-tailed Godwit) which breed in rural areas behind the dikes, such as meadows, and arable land.
The herbivores Widgeon Barnacle Goose and, to a lesser extent, Brent Goose, use meadows and arable land as feeding areas during the period September/October to March/April. A shift in habitat use from traditional natural feeding areas, such as eelgrass beds and salt marshes, to agricultural land (e.g. intensively used grassland areas) has occurred and resulted in damage to agricultural land and, as a consequence, conflicts with farmers. The concerned species have been forced to feed on agricultural grassland areas because of losses, changes and/or disturbance of the natural habitats. The natural habitats have been reduced in quality and quantity by impacts of agriculture, industry, flood control and recreational use. Human disturbance from increasing recreational use of the land in front of the dikes and tidal flats results in more intensive utilization of the rural areas.

At night, marshes, grasslands and fields behind the dikes are heavily utilized by Widgeons, especially when not disturbed. However, the use of agricultural land by geese and ducks, and in consequence also the conflicts, are concentrated in specific localized areas. This is not only dependant on the management of the concerned area, but also on the management of habitats and geese elsewhere. The developments in agricultural use (e.g. set aside or transformation of meadows to farmland) also have consequences in the use by geese and ducks.

How to proceed

The most important element in future policy and management is to work towards sustainable agricultural use of the rural area. However, it is evident that this can only be done in close cooperation, and on a voluntary basis, with the agricultural sector.

Regional and local authorities have an important responsibility to stimulate sustainable use in cooperation with the people who live in the area.
Also, measures in the tidal area and salt marshes will help to provide favorable conditions for the concerned bird species.

8.1 Trilateral policy and management

Wind energy and agricultural use are the main relevant human activities regarding the Target ‘favorable conditions for birds in rural areas’.
Trilateral measures regarding the management of human activities which are relevant for the rural area, and which have also relevance for the special Targets on birds, such as hunting, are dealt with comprehensively in Chapter 9 on birds.
Currently, an “International Flyway Management Plan Dark-bellied Brent Goose” (single species Action Plan in accordance with the AEWA) is being elaborated and will be submitted to the next Trilateral Governmental Conference.

Agricultural use

8.1.1 Sustainable agriculture for improving nature conservation, maintaining typical landscape elements and protection of cultural heritage will be supported, amongst others, financially.

8.1.2 Nature areas reclaimed for agricultural purposes should be restored, where possible, through voluntary cooperation with, and active participation of, the owners.

8.1.3 Initiatives of the agricultural sector aiming at reducing the application and unintended impacts of pesticides and other toxic substances and fertilizers in the rural area will be supported, amongst others, financially.

8.2 Trilateral projects and actions

8.2.1 A discussion with local farmers in the polder areas to decide on the most promising farming methods for the long and the short term with the aim of combining the Targets with sustainable agriculture.

8.2.2 An exploration of the possibilities for sustainable agriculture and for the combination of agriculture and nature management in the rural area.

9 Birds

Birds use different habitat types of the Wadden Sea Area. Therefore, all habitats which are used by one species or population are linked to and depend on each other. For example, feeding areas and appropriate roosting sites on the tidal flats or salt marshes should be available in sufficiently close distance to the breeding site of a species. During various periods, all these habitats are important habitat types for the different species and are essential for the natural development of these species in the Wadden Sea Area and should thus be taken into consideration while designing a management strategy for the protection of birds/different bird species/populations. Therefore, the bird Targets, including their subtargets, are, more or less, relevant for all habitat types in the Wadden Sea Area.

Management measures which have a habitat-crossing character, as well as measures for bird species which have their main distribution in a specific habitat type, will be addressed.

Status

The conservation status of birds in the Wadden Sea Area is primarily determined by weather conditions, food availability, disturbance, as a result of various human activities, and by pollution, in particular, by heavy metals, organic micro-pollutants and oil.
High numbers of moulting ducks and geese are present in the Wadden Sea Area every year. These birds are flightless during moult and extremely susceptible to disturbance. The herbivores Widgeon, Barnacle Goose and, to a lesser extent, Brent Goose, use meadows and arable land as feeding areas during certain periods of the year. A shift in habitat use from traditional natural feeding areas, such as eelgrass beds and salt marshes to agricultural land, occurred and resulted in damage of agricultural land and in conflicts with farmers. The breeding populations of particularly threatened species such as Kentish Plover and Little Tern are highly dependent on habitats, like sandy beaches and primary dunes. The offshore-area is an important feeding, roosting and moulting area for divers, Eider and other seaducks, such as Common Scoter.

Targets

Favorable conditions for migrating and breeding birds:

- a favorable food availability;
- a natural breeding success;
- sufficiently large undisturbed roosting and moulting areas;
- natural flight distances.

Assessment

Favorable food availability

A favorable food availability for birds is aimed for. Based on the guiding principle, unnatural food resources for birds should be avoided. However, as long as unnatural food resources are present in the Wadden Sea Area, they should be accepted as part of the system and as a natural component of the particular ecosystem.

A number of human activities interfere with the natural food availability of certain bird species. This interference may have consequences for the food availability in years with low shellfish stock. Activities which increase the food availability for certain species and favor some species with further consequences for the entire community structure should be addressed. This concerns fishery discards, landfill dumps in the vicinity of the Wadden Sea Area, eutrophication, as well as, agricultural practices in island polders and areas behind the dikes.

Natural breeding success

Under the parameter “natural breeding success” also, the importance of natural habitats as a condition for natural distribution and densities of breeding birds and their breeding success should be taken into consideration.
Natural distribution and densities of breeding populations are especially important for endangered bird species highly dependent on sandy beaches and primary dunes (Kentish Plover, Little Tern). The present breeding populations of these species are particularly threatened and severely reduced compared to their former (natural) sizes.

In general, the reproduction success of breeding birds in the Wadden Sea Area should not be influenced by human factors (i.e. chemical pollution, disturbance). Hatching and breeding success are, generally, more influenced by disturbance and natural factors, i.e. weather conditions, flooding and predators, than by pollutants. However, also factors like predator density and the frequency and level of flooding may be affected by human activities (building of dikes and dams to islands, causing an increase of ground predators).

Sufficiently large undisturbed roosting and moulting areas

Sufficient numbers of large undisturbed roosting sites in the Wadden Sea Area should be distributed along the whole coastline and they should not lie far apart, and in close proximity, to the feeding area. A criterion for the size of an undisturbed roosting area should be that birds can roost there without being disturbed by human activities outside the area.

Besides food availability, the lack of disturbance is the primary factor favoring high numbers of Shelducks and Eiders to moult in a specific area. These birds are unable to fly during moult and are extremely susceptible to disturbance with escape/flight distances up to some kilometers. Boats, and other sources of disturbance, have a strong influence on the present distribution of moulting ducks in the Wadden Sea Area.

Natural flight distances

"Flight distance" is the distance between a bird and a human disturbing factor to which the bird reacts by fleeing. Though the "natural" flight (escape) distances of birds in the Wadden Sea Area are not known, the present flight distances, which are a reaction to human disturbance, can be regarded as long because the birds have experienced man as an enemy. These unnaturally long flight distances cause other human activities to work as disturbance as well, which would often not cause effects if the flight distances were shorter. On the other hand, the possibilities of habituation of birds in "safe" areas must be taken into account.

Human activities which may disturb are, inter alia, hunting, some military activities, recreation, air traffic and wind turbines. The disturbance by military and civil air traffic has been reduced by the introduction of minimum flight altitudes. The shooting ranges at Den Helder, Noordvaarder and Sylt have been abolished.

How to proceed

An important element in future policy and management is to work towards acceptable solutions to reduce the conflict between food requirements for birds and the interests of fisheries and agriculture. It is important to avoid food shortage due to disturbance of other human uses (such as recreational activities, aerial traffic, wind turbines and hunting), as well as, human activities which favor certain species of birds by increasing their food supply, e.g. fishery discards, garbage deposits close to the Wadden Sea Area, eutrophication and agricultural practices in island polders and areas behind the dikes. However, it is evident, that this can only be done in close cooperation with the fishery and agricultural sectors.

Measures to protect breeding, roosting and feeding habitats can be achieved by establishing a sufficient number of bird reserves of proper size and through the management of activities. Breeding populations of Kentish Plover and Little Tern, which are highly dependent on sandy beaches and primary dunes, are particularly threatened. The situation of these species should be improved. The same is valid for migrating and moulting birds. Safe moulting and roosting sites which lie close to their feeding areas are necessary for birds to avoid energy loss.

It is important to avoid the construction of wind turbines in the rural area where this may cause a significant impact on birds.

Flyway-Cooperation Agreements have already been established with The Wash and Guinea Bissau. In the framework of the African-Eurasian Waterbird Agreement, international conservation plans will be compiled for long-distance migrating waders and various other species.

9.1 Trilateral policy and management

Bird conservation and management, at the general trilateral policy level, is subordinated to the Guiding Principle, i.e. a natural and, as far as possible, dynamic Wadden Sea, even if natural dynamics may lead to less favorable conditions for some bird species or populations. That means, that the Guiding Principle is more important than special conservation measures for certain species.
General points regarding the flyway cooperation and also specific measures for the management of different human activities which have effects on breeding and migratory bird populations in the Wadden Sea Area were already laid down in the Esbjerg and the Leeuwarden Declarations.

The general management measures for specific habitats, listed under the headlines of the habitat categories, can be relevant for bird populations in general.

Site protection

9.1.1 The conditions for breeding birds will be improved by appropriate management.

9.1.2 It is the aim to improve the conditions for migratory birds during roosting and feeding, as well as, for seaducks in the offshore area during moulting, through integrated management.

Interference with the food conditions for birds

Mussel and cockle fishery

9.1.3 The negative effects of cockle fishery are being limited by:
- Cockle fishery is not allowed in the German part of the Conservation Area;
- Cockle fishery is not allowed in the Danish part of the Wadden Sea Area, with the exception of some small areas along the Esbjerg shipping lane and in the Ho Bay;
- Cockle fishery is allowed in the Dutch part of the Wadden Sea Area, but has been limited by the permanent closure of considerable areas; there are possibilities for additional restrictions to safeguard food for birds. A co-management scheme with the fishing industry is in operation, in which the protection and enhancement of the growth of wild mussel beds and Zostera fields are central elements. (Identical with 4.1.16).

9.1.4 The negative effects of mussel fishery are limited by the permanent closure of considerable areas. In addition, the management of fishery on mussels aims, inter alia, at protecting and enhancing the growth of wild mussel beds and Zostera fields. (Identical with 4.1.17).

9.1.5 Mussel fishery will, in principle, be limited to the subtidal area. Based on national management plans, which are documented in the Progress Report, fishery on the tidal flats may be granted. The fishery sector is called upon to exchange information on the existing practices and to investigate possibilities for minimizing impacts of mussel fishery, in general, and seed mussel fishery, in particular. (Identical with 4.1.18).

Acoustic and visual disturbance

Disturbances due to recreational and other human activities

9.1.6 Disturbance in significant breeding areas will be reduced and access to these areas will be made more predictable for birds, i.e. using only certain footpaths on salt marshes, beaches and dunes (information system for visitors).

9.1.7 It is the aim to reduce the disturbance in significant breeding areas caused by grazing through the reduction of the grazing pressure and through postponing the beginning of the grazing period, except where a certain intensity of grazing is necessary for coastal protection measures

9.1.8 Driving cars in breeding areas on beaches and in dunes is prohibited.

Wind energy

9.1.9 The construction of wind turbines in the Conservation area is prohibited. (Identical with 1.1.4).

9.1.10 The construction of wind turbines, in the Wadden Sea Area outside the Conservation Area, is only allowed, if important ecological and landscape values are not negatively affected. (Identical with 1.1.5).

Hunting

9.1.11 Hunting of migratory species has been, or will be, progressively phased out in the Conservation Area or in an ecologically and quantitatively corresponding area in the Wadden Sea Area.

9.1.12 Lead pellets will not be used in the Wadden Sea Area.

9.1.13 Hunting of non-migratory species is, in principle, only allowed in the Conservation Area, if migratory species are not harmed.

Civil air traffic

9.1.14 The impact of civil air traffic in the Wadden Sea Area will be limited.

9.1.15 New civil airports will not be constructed in the Wadden Sea Area.

9.1.16 The expansion of existing civil airports in the Wadden Sea Area is restricted to cases where this is essential in order to increase the safety of air traffic.

9.1.17 A minimum flight altitude of civil air traffic of 1,500 to 2,000 feet (450 - 600 m) is established in the Wadden Sea Area. Exemptions can be granted for safety reasons and will be confined to designated flight corridors situated in less vulnerable parts of the Wadden Sea Area.

9.1.18 The use of ultra-light aircraft will be prohibited in the Wadden Sea Area pending national legislation, with the exception of scientific and enforcement purposes.

9.1.19 Advertisement flights are, in principle, prohibited in the Wadden Sea Area.

9.1.20 Helicopter flight routes and altitudes are established in such a way that the disturbance to wildlife is minimized in the Wadden Sea Area.

Military activities

9.1.21 Disturbance caused by military activities has been, or will be, reduced and the possibilities for further concentrating and/or phasing out military activities will be regularly examined.

9.1.22 The negative effects of low altitude flight routes of military aircraft have been, or will be, reduced by reducing the number of flights and the maximum speed.

9.1.23 Action to minimize disturbance caused by military air traffic in the Wadden Sea area will be taken on a coordinated basis.

9.1.24 High priority will be given to the assignment of redundant shooting ranges as nature protection areas.

9.2 Trilateral projects and actions

9.2.1 An inventory of all important and potential roosting sites along the coastline of each country, in conjunction with an evaluation of available knowledge on the necessity for undisturbed roosting sites, in order to investigate the possibilities for creating undisturbed roosting sites.

9.2.2 An evaluation of available knowledge on the necessity of undisturbed moulting sites for seaducks in the offshore area, in order to investigate the possibilities for creating such undisturbed moulting sites, aiming at improving the conditions during moulting.

9.2.3 An investigation into the possibilities to come to a coordinated management for herbivorous species (e.g ducks and geese) on inland sites.

9.2.4 The exploration of possibilities for improving the conditions for breeding birds in dunes and on beaches in cooperation with responsible authorities, especially on the local level, and relevant groups, with the aim to discuss the results and to take appropriate measures.

9.2.5 An inventory and assessment of the reduction of disturbance caused by military activities in the three countries.

10 Marine Mammals

The Common Seal, the Grey Seal and the Harbour Porpoise may be regarded as indigenous Wadden Sea species. Water is the main or exclusive element of these marine mammal species. The year round, the Common Seal uses other habitats than water, such as sand banks in the tidal area and beaches, the Grey Seal uses also dunes and salt marshes. All these habitats are essential for the maintenance of the vital biological functions of seals, such as whelping, nursing, breeding, moulting and feeding.

The species groups with an overlapping habitat demand, such as marine mammals and birds, need special attention because of their vulnerability to disturbance and pollution, and a possible food resource competition with Man. As top predators, these species have an important indicative function of the quality of the Wadden Sea ecosystem. Seals are the ambassadors and most attractive species of the Wadden Sea Area. Therefore, the opportunity for tourists to observe seals in their natural environment should be maintained.

Status

The present and short term conservation status of Common Seals, Grey Seals and Harbour Porpoises in the Wadden Sea Area is primarily determined by two developments: disturbance, as a result of various human activities (such as tourism and recreation activities, air traffic, some military activities) and pollution, in particular, by heavy metals and organic micro-pollutants. The present situation regarding food supply does not influence the conservation status of seals. Whilst measures to reduce pollution have to be taken mainly outside the Wadden Sea Area, measures to protect seal habitats have to be achieved within the area itself by creating seal reserves in such a way that disturbance is limited to a minimum.

In the years after the virus epidemic in 1988, the population of the Common Seal has shown a rapid recovery. During coordinated flights in the entire Wadden Sea Area, a total of 12,927 seals was counted in 1997, of which 2,783 were pups.

Today, two Grey Seal breeding sites exist in the Wadden Sea Area. One near the island of Vlieland in The Netherlands with about 315 animals, where at least 30 pups are born each year, and one small reproductive colony of about 30 to 40 animals in Schleswig-Holstein, Germany.

According to sightings, the Harbour Porpoise mainly inhabits coastal waters not deeper than 20 m.
Systematic aerial and shipping surveys, which were carried out in the framework of the European Commission project SCANS and a project of the University Kiel in the entire North Sea and parts of the Baltic Sea, have documented that the area west of the Knobsände off Amrum and the island of Sylt is the most densely populated one within the German Bight. Long-term surveys

carried out by volunteers on the islands Amrum and Sylt, documented that Harbour Porpoises in this area also occur directly near the beach the whole year round. Compared to other parts of the North Sea, there is an extraordinarily high density of mother calf-groups (the suckling-period of this species lasts approx. 8 months) in this area. It can be concluded that this area is an important rearing area for Harbour Porpoises.

Targets

Viable stocks and a natural reproduction capacity of the Common Seal including juvenile survival.

Viable stocks and a natural reproduction capacity of the Grey Seal including juvenile survival.

Viable stocks and a natural reproduction capacity of the Harbour Porpoise.

Assessment

The term "viable stocks" has to be specified in such a way that a connection with management is possible. The numbers that can be expected according to the natural carrying capacity of the Wadden Sea Area depend on factors that are defined by the fish stocks in the North Sea, suitable undisturbed haul-out sites and on the effects of diseases and parasites in dense populations. The absence of significant human impact on the population, to be judged and monitored in the course of years, is the standard for the first part of the Target.

The "natural reproduction capacity" of seals depends on many factors - water quality, disturbance, population size - and can, probably, not be expressed by a simple number or range. Based upon regular best expertsí judgement, it will have to be assessed whether the reproduction can be regarded as natural. This second part of the Target is one of the main, still not really solved, problems of the last decades: the reduced reproduction rates due to PCBs and other organic micro-pollutants. The production of 0,85 - 0,95 pup per mature female per year is the proposed reference for the natural reproduction capacity.

In terms of numbers, the present Common Seal population is regarded as viable. However, the juvenile mortality is very high (over 40% instead of 20 - 25%). Despite the good protection of the main resting and nursing places, the environmental conditions are still not satisfactory.

The present Grey Seal population in the Wadden Sea Area cannot be regarded as viable. The stock in The Netherlands mainly grows because of immigration from Great Britain. Grey Seals need high sands (not flooded during high tide) or beaches and salt marshes during whelping and nursing. There ought to be means to keep areas free of interference in a flexible way. Furthermore, there is not enough knowledge about the natural reproduction capacity of Grey Seals in the Wadden Sea Area.

For Harbour Porpoises, a detailed assessment is not yet available due to limited knowledge. Small cetaceans are especially sensitive to disturbance and effects from high-speed boats (e.g.

jet-skis) and to the impact of fishery (by-catch). Possible effects of leisure boats and ships are strong underwater noise, which disturbs the communication and orientation system of small cetaceans, the risk of collision with high-speed boats, which can hardly be located by wales, and disturbance causing permanent separation of mother and calf.
By-catches from fishery are a main threat to Harbour Porpoises. Based on an extrapolation, the number of animals killed in Danish gill-nets in the whole North Sea is some 7,000 animals per year.

How to proceed

Both with regard to the chemical and physical conditions - i.e. disturbance level - of the habitat of Common and Grey Seals, as well as, Harbour Porpoises, improvements are necessary.

For a better assessment of the status of the Grey Seal in the Wadden Sea Area, the general knowledge on reproduction and mortality should be improved. The same holds true for Harbour Porpoises because, at present, there is not enough knowledge about this species to be able to develop references, neither for viable population nor for natural reproduction parameters.

10.1 Trilateral policy and management

Common and Grey Seal

The 'Agreement on the Conservation of Seals in the Wadden Sea' (Seal Agreement) was enacted on October 1, 1991 as the first agreement as defined in Article 4, of the Convention on the Conservation of Migratory Species of Wild Animals (The Bonn Convention). The agreement was concluded between the Wadden Sea states with the aim to cooperate closely in achieving and maintaining a favorable conservation status for the Common Seal population of the Wadden Sea Area. The Seal Agreement contains provisions, amongst others, on research and monitoring, on taking and on the protection of habitats, which have been specified in the 'Conservation and Management Plan for the Wadden Sea Seal Population 1991 - 95' (Seal Management Plan) and the revised Seal Management Plan 1996 - 2000. The latter also includes additional measures for the protection of the Grey Seal.

Regarding the implementation of the Targets for the Common and the Grey Seal, reference is made to the specific measures related to the different habitat types and, especially, to the Seal Management Plan 1996 - 2000. The revised Seal Management Plan is based on a comprehensive evaluation of the first Seal Management Plan 1991 - 1995, as well as, the results of the Joint Seal Project and the principles and guidelines concerning taking of seals, rehabilitation and releasing of seals, which are given in the § 60 of the Leeuwarden Declaration. (See LD §56 - 60; Conservation and Management Plan for the Wadden Sea Seal Population 1991 - 1995, ED §26; Conservation and Management Plan for the Wadden Sea Seal Population 1996 - 2000, SO March 1996).

Measures for the implementation of the Targets on seals are especially listed under "Required effort and objectives" and "Actions in 1996 - 2000" in the Seal Management Plan which are divided into actions on the trilateral and national level. These actions include measures which should be implemented in different habitats and for different purposes, such as research, monitoring and protection of habitats. In the following, the existing trilateral decisions, which have already been taken in the Esberg and Leeuwarden Declarations, are mentioned and some

new proposals regarding trilateral policies, management measures and actions are listed. The general management measures regarding specific habitat types such as tidal area, salt marsh and offshore area, can also be relevant for marine mammals in general.

According to the Leeuwarden Declaration §61, the principle and guidelines "to reduce the current number of seals taken from, and released to, the Wadden Sea to the lowest level possible" should also apply to the Grey Seal. Therefore, the "Conservation and Management Plan for the Wadden Sea Seal Population 1996 - 2000" (Senior Officials, March 1996) includes "Additional measures for the protection of the Grey Seal".

Harbour Porpoise

This species was not taken into special consideration during the decisions of the last Trilateral Governmental Conferences. In the framework of the Agreement on the Conservation of Small Cetaceans of the Baltic and the North Sea (ASCOBANS), the Harbour Porpoise was included and the Wadden Sea Conferences welcomed the agreement and the cooperation with its respective bodies (ED §28 and LD §63).

10.1.1 It is the aim to protect important breeding/rearing areas of the Harbour Porpoise in the Wadden Sea Area and adjacent areas through appropriate measures.

10.1.2 The public will be informed about small cetaceans in the Wadden Sea Area and the North Sea on a common basis in cooperation with ASCOBANS.

10.2 Trilateral projects and actions

10.2.1 The consideration, on the basis of scientific evidence, of the designation of areas in the Wadden Sea Area and adjacent areas off Sylt and Amrum, as well as, in the Danish part, as areas of special concern, especially as breeding/rearing area for the protection of the Harbour Porpoises.

10.2.2 An investigation, in consultation with responsible local governments and relevant groups into the available possibilities for closing, in a flexible way, areas where Grey Seal pups rest regularly.

10.2.3 An investigation of technical solutions and improvements in consultation with responsible fishery groups, for the prevention of incidental catch of marine mammals in drift nets and set nets, with the aim of minimizing by-catch.

Appendix I
Maps

See German version.

Appendix II
Index of Activities

The following activities have been distilled from part II of the Plan to provide an overview of the activities under each of the Targets. An activity may be addressed under more than one Target. The numbers refer to the paragraphs as entailed in part II.

Activity		1 Landscape and culture	2 Water and sediment	3 Saltmarshes	4 Tidal area	5 Beaches and dunes	6 Esturaries [1]	7 Offshore Area	8 Rural Area	9 Birds	10 Marine mammals
1	Agricult ural use		2.1.2	3.1.1 - 3 3.1.11 3.1.13					8.1.1 - 3	9.1.7	
2	Civil air traffic									9.1.14 - 20	
3	Coastal protection			3.1.4 - 10	4.1.1 - 2 4.1.11	5.1.2 - 3 5.1.5 - 7		7.1.1 7.1.3		9.1.7	
4	Dredging and Dumping		2.1.6 - 7		4.1.6 - 8 4.1.11 4.1.15		6.1.2 - 3				
5	Energy resources										
5.1	Gas & oil		2.1.8 - 10	3.1.14	4.1.10	5.1.4					
5.2	Pipelines		2.1.9	3.1.16	4.1.13	5.1.4					
5.3	Wind energy	1.1.4 - 5								9.1.9 - 10	
6	Extration Sand & Clay			3.1.9	4.1.11 - 12			7.1.2 - 3			
7	Fisheries										
7.1	Cockle fishery				4.1.16					9.1.3	
7.2	Mussel fishery				4.1.17 - 19					9.1.4 - 5	
7.3	Other fisheries - Oyster culture				4.1.20						
8	Ground water extraction					5.1.10					
9	Harbor and industry		2.1.1	3.1.14	4.1.3 4.1.5	5.1.4	6.1.1				
10	Hunting									9.1.11 - 13	
11	Infrastructure			3.1.14 - 15	4.1.3 - 4 4.1.14	5.1.4					
12	Military activities									9.1.21 - 24	
13	Nature and Landscape management	1.1.2		3.1.1- 5 3.1.10 -11		5.1.1 5.1.3 5.1.5 5.1.9	6.1.4 - 5	7.1.2	8.1.1 - 2	9.1.1 - 2 9.1.6 - 7	10.1.1
14	Pollution		2.1.1 - 10	3.1. 13					8.1.3	9.1.12	
15	Public awareness	1.1.3		3.1.12	4.1.24	5.1.8				9.1.6	10.1.2
16	Recreation and tourism										
16.1	Watersport				4.1.21 - 24						
16.2	Other tourist activities			3.1.12		5.1.8				9.1.6 9.1.8	
17	Shipping		2.1.3 - 5		4.1.6 4.1.9 4.1.22 - 23						
18	Species/site protection	1.1.1		3.1.1		5.1.1	6.1.4			9.1.1 - 2	10.1.1

[1] The policies for important elements of the estuaries, i.e. the water, the salt and brackish marshes, and the rural areas, have been formulated in Part II, Chapter 1, 3, 8 and 9 respectively. The relevant parts of these policies also apply to valuable parts of estuaries. It concerns here, in particular, dumping of dredged material, agriculture, hunting, fisheries, recreation and energy.

Appendix III
Glossary

Background concentration, Background value

Concentration of a substance in an environment not influenced by human activities.

Baseline

Natural and artificial lines to calculate the seaward border of coastal waters and the extension of the territorial waters. It is the low water line along the coast or, where appropriate, an artificial line in the area of bays, estuaries or between islands. The baseline is defined according to the United Nations Law of the Sea of 1982 (Articles 3 - 16).

Benthic stock

The total amount of all aquatic organisms living in, or on, the sea floor.

Best Available Technique

The latest stage of processes, facilities or methods for limiting discharges and emissions of wastes, which is also practically feasible.

Best Environmental Practice

The application of the most appropriate combination of environmental control measures and strategies (OSPAR Convention 1992, Appendix I).

Bio-accumulation

The accumulation in an organism, mainly in soft parts such as liver and muscles, but also in hard parts (bones etc.), of substances (e.g. heavy metals, pesticides) after passive or active uptake from the water.

Biotope

An area, characterized by certain environmental conditions, in which different species and communities live and are interconnected.

Brackish water limit

Border of seawater and freshwater in estuaries. The hydrographical brackish water limit is 0.5 PSU (practical salinity unit).

Breeding success

Number of fledged young birds per year and breeding pair. To be differentiated from “hatching success”, which means number of hatched birds of all eggs and “fledging success”, which means number of fledged young birds of all hatched birds.

Brushwood groyne

See Groyne.

By-catch

Those organisms caught during fishing which are too small or are not the target species. When thrown back into the sea they are called “discard”.

Carrying capacity

The maximum population of a given organism that a particular environment can sustain.

Catchment area

The area from which a certain river or a sea derives its water, e.g. all precipitation on this area finally flows into one certain river /sea.

Co-management

Co-management implies the involvement of stakeholders in the making and implementation of decisions about the management of e.g. fishery resources. It has two main features: consultation and delegation. Consultation between the central administration and the user groups about the contents of the management strategies and the delegation of specific management functions to responsible user group organizations. (Report of the Seminar on Co-Management, 9-10 January 1997, Groningen, NL).

Cuttings

Material formed during the drilling process, i.e. rock particles, sand etc. mixed with drilling muds (see drilling muds).

Deepwater route

Special routes with an international status which have been instituted for deep-draught ships and ships with dangerous substances in bulk.

Discards

Fishery offal and by-catch disposed of into the sea.

Drilling muds

Fluids used in drilling operations for cooling the drilling chisel and transporting cuttings to the surface. Drilling muds can either be based on water or oil. They contain various other components, e.g. e.g. heavy metals, bentonite, inorganic salts, surfactants, organic polymers, detergents, corrosion inhibitors, biocides, lubricants in the form of oil-water emulsions.

Ecosystem

Natural functional unit of organism, as well as, natural and artificial abiotic compartments which are interconnected concerning the exchange of energy, substances and information.

Environmental Impact Assessment

Comprehensive investigation of possible effects of projects or measures, with regard to the ecological impacts.

Flight corridors

Defined air corridors (height and width) to which air traffic is restricted.

Flyway cooperation

International cooperation concerning the East-Atlantic-Flyway of migratory birds between the countries of the flyway. The Flyway connects the breeding areas in the Arctic and the overwintering areas in West-Europe and West Africa.

Gill-nets

Rectangular nets used for passive fishery placed vertically in the water column.

Green beach plains

Beach area shielded by primary dunes enabling sparse vegetation.

Groyne

Comstruction built parallel or perpendicular to the coastline with the aim of enhancing sedimentation of fine-grained material and/or reducing wave and current energy. They may consist of brushwood, stone or concrete.

Habitat

The structural environment where a species naturally or usually lives or is found.

Hydrofoil craft

Boat / Vessel equipped with structures (plates or fins) which, when the boat is in motion, raise the hull out of the water, thereby reducinq resistance and, consequently, allowinq for hiqher

Indigenous Wadden Sea species

Species which have occurred naturally in the Wadden Sea for a long period of time. Contrary to non-indigenous species which have been imported by Man or which have immigrated into the Wadden Sea in recent times

Intertidal area

See Tidal flats.

Ishohaline

A contour line on a map connecting points of equal salinity (at a particular time).

Isobath

A contour line on a map connecting points of equal depth.

Mound

A heap, or a pile of earth, either natural or artificial; in this case, built by man in coastal areas, tide streams and estuaries for protection against storm tides.

Oil-based muds

See drilling muds.

Operational discharges

Discharges of oil, garbage and ha~ardous substances from ships during normal operation practices lin contrast to dumping and discharge). Regulated by the MARPOL Convention.

Outer delta

Outer deltas are underwater sand banks at the outer (North Sea) side of the tidal inlets between the islands. They are also called ebb deltas because they are formed during ebb-tide when water is transported from the Wadden Sea through the inlets to the North Sea. The sand, that is transported with the outflowing water, is deposited on the North Sea side of the inlet in an arch shaped form.

Pioneer zone

Transition area between salt marshe and tidal area, located between middle tide low water and middle tide high water, dominated by Salicornia and sometimes with scattered Spartina tussocks.

Primary dunes

Wind created sand accretion (up to 1 m), with or without sparse/scattered vegetation, dominated by sea wheat grass (Agropyron junceum). Transition phase in the development to secondary dunes (white dunes).

Primary dune valleys

Valleys parallel to the beach between two dune walls with wet conditions (at least in winter), increasing dominance of fresh water, sometimes also moor. Depending on local conditions, dune valleys have characteristical vegetations (wet heaths, rush and sedge swamps, as well as, aquatic and amphibic communities). Secondary dune valleys are created by blow-out and are located in wind direction.

***Primary production**

The production of living matter by photosynthesizing organisms (e.g.. plants, plankton) or by chemosynthesizing organisms (e.g. bacteria). Usually expressed as grams of carbon per square meter per year, because carbon is a common element in all living matter.

Resilience

The ability to return to the original state (or original dynamic) after a temporary disturbance (e.g. natural events or human interference).

Sabellaria reefs

The tube building bristle-worm *Sabellaria spinulosa* forms sand reefs. This characteristic species of the subtidal channels disappeared almost completely. Only two recent observations of Sabellaria reefs are known (near the islands of Mellum and Amrum, Germany).

Secondary dunes

Up to 20 m high dunes. First stable stage of dune succession with vegetation; dominated by marram grass (Ammophila arenaria).

Shore reception facilities

Facilities in ports for the reception of oily and chemical residues and wastes from ships.

Sluicing regimes

Specific scheme according to which fresh water is sluiced into the sea at certain periods.

Spring high tidewater line, spring low tide water line

Highest, respectively, lowest water line during spring tide (which is caused by the summation of the gravitation of moon and sun during full-moon and new-moon).

Stakeholders

Any person, institution, organization, agency, department, authority, club, association etc. which has, in the broadest sense, an interest in, or association with, a particular issue.

Subtidal

Coastal area below the spring low tide water line, always covered by water (sublitoral).

Sustainable use

The use of components of biological diversity in a way, and at a rate, that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations (Convention on Biological Diversity, 1992).

Synergism

Interaction of several components, intensifying each other, e.g. influence of a combination of contaminants on organisms.

Tidal basin

System of tidal channels and tidal flats between two water sheds (see Water Shed) ranging from the dike to approximately the 20 m depth line.

Tidal flat

Area which is regularly flooded/covered by water during high tide (mud flat, eulitoral).

Top predators

Animals which feed on other animals and which are themselves not a prey for other species. The only exception is hunting by Man. Examples in the Wadden Sea are seals, foxes and several bird species.

Water-based muds

See Drilling muds.

Watershed

The area between two tidal basins. Water sheds have a higher elevation than other tidal flats and are flooded last.

Xenobiotics

Man made substances.

Zostera fields

Seagrass meadows or eelgrass fields (Zostera marina and Z. noltii) in the tidal area.

Annex II
Common Package TMAP

Common Package TMAP*

Contaminants	**1**	TBT in water and sediment
	2	Metals in sediment
Nutrients	**3**	Inorganic nutrients in water
Salt Marshes	**4**	Spatial extension
	5	Agricultural utilization: grazing
Benthos	**6**	Macroalgae
	7	Eelgrass
	8	Macrozoobenthos communities
	9	Blue Mussel beds
	10	Contaminants in flounder
Plankton	**11**	Phytoplankton
Fish	**12**	Contaminants in blue mussels
	13	Mussel/Cockle/Shrimp fishery
Beaches and Dunes	**14**	Spatial extension
Birds	**15**	Breeding birds: numbers and distribution
	16	Breeding birds: contaminants in bird eggs
	17	Migratory birds: numbers of waterbirds in counting units
	18	Beached Bird Survey
Seals	**19**	Population parameters by aerial survey
Recreational Activities	**20**	Boats at sea
	21	No. of guided tours
	22	Air traffic
General Parameters	**23**	Coastal protection measures
	24	Geomorphology
	25	Flooding
	26	Land use
	27	Weather conditions
	28	Hydrology

* The parameters in the Common Package will be monitored according to the agreed common TMAP Guidelines.

Annex III

Memorandum of Intent
Guinea-Bissau - Wadden Sea
Work Program 1998 - 2000

An interim outline on a three-year work program 1998-2000

Objective

The program is designed to encourage an international interchange of knowledge and ideas and to develop a multi-disciplinary approach to nature protection and management issues.

The first step of the program will be to continue to train an ornithological team in Guinea-Bissau to carry out research and monitoring work, especially in the field of waders wintering in Guinea-Bissau and migrating to the Wadden Sea.

The next step of the program will be to establish an organization for ornithological research, monitoring and public information in Guinea-Bissau, which will be able to continue the work initiated.

Projects

Project 1

Subject:
Research, monitoring and surveys on waterbirds and important bird areas in Guinea-Bissau

Objective:
To train an ornithological team in Guinea-Bissau to carry out the following tasks:

a) To provide data on the abundance and species composition of waterbirds by monthly counts on tidal flats of Bubaque, Soga, and Orango, and in the Ramsar site Lagoa de Cufada.
b) To monitor changes in abundance and species composition of waders by making a survey of the whole coastal zone of Guinea-Bissau as complete as possible every third year, next time in 1999.
c) To provide data on the breeding colonies of shorebirds by visiting selected uninhabited islets of the Bijagos Archipel 3 to 4 times per year.
d) To provide data on Important Bird Areas (IBA-sites) in Guinea-Bissau as a part of current international programs.
e) To formulate preliminary management policy proposals.

Contents:
Education and training of an ornithological team in Guinea-Bissau in 1998-2000. Liaison between scientists and technicians in the Wadden Sea States and Guinea-Bissau to collect data on monthly counts from 1998 to 2000, to make a survey of IBA-sites in 1998, to make a full survey of waterbirds in the coastal zone in 1999, and to collect data on breeding colonies from 1998 to 2000.

Participants:
Guinea-Bissau: GPC, INEP, in cooperation with IUCN.
Wadden Sea States: Joint Monitoring Group of Migratory Birds in the Wadden Sea.

Implementation:
Education and training of an ornithological team in Guinea-Bissau by trilateral and Portuguese ornithologists in Guinea-Bissau from 1998 to 2000.
Survey of IBA-sites in 1998.
Survey of the whole coastal zone of Guinea-Bissau by trilateral ornithologists in cooperation with the ornithological team in 1999.
Elaboration of management policy proposals in 2000.
Publishing a brochure on the Memorandum, the areas and the work program to inform, amongst others, the authorities.
Exchange of information from 1998 to 2000.

Estimated costs:
1998-2000: 136,000 US$

Project 2

Subject:
Establishing an organization for ornithological research, monitoring, education and public information in Guinea-Bissau.

Objective:
To provide for the continuation of ornithological work in Guinea-Bissau in order to:

- conduct ornithological work of all kinds,
- undertake education and public information, and
- carry out awareness campaigns of the local population.

Contents:
Liaison between scientists and technicians in the Wadden Sea States and Guinea-Bissau to publish small books on birds for schools in Portuguese and/or Creole, to publish lists of birds of Guinea-Bissau, to publish brochures of sustainable use of flora and fauna etc., to carry out campaigns for collecting bird rings, handling data from bird rings etc.

Participants:
Guinea-Bissau: GPC, INEP, in cooperation with IUCN.
Wadden Sea States: Joint Monitoring Group of Migratory Birds in the Wadden Sea.

Implementation:
Establishing the organization in 1998.
Exchange of information from 1998 to 2000.
Elaborating and publishing a school booklet on the most common birds from 1999 to 2000.
Carry out awareness campaigns for bird rings from 1998 to 2000.

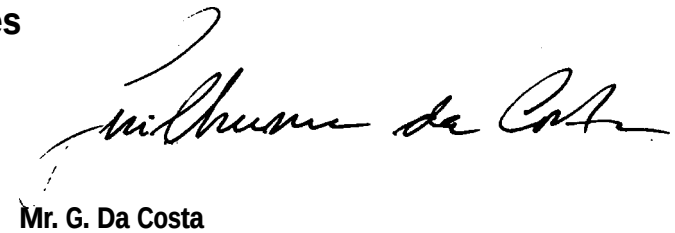
Estimated costs:
1998-2000: 20,000 US $

Organizational aspect

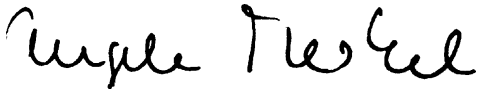
The overall project manager is
the National Forest and Nature Agency in Denmark and
the Coastal Planning Office and INEP in Guinea-Bissau
with the task
- to oversee the implementation of the projects;
- to ensure that it is in accordance with the planned budgets;
- to solve any matter of common concern.

The Contracting Parties shall review the results of the program based on a brief evaluation of the projects in 2000.

Signatures



Mr. G. Da Costa
National Director, Bureau of Coastal Planning of The Ministry of Rural Development, Natural Resources and the Environment on behalf of Guinea-Bissau



Dr. A. Merkel
Minister for the Environment, Nature Conservation and Nuclear Safety of The German Ministry for the Environment, Nature Conservation and Nuclear Safety on behalf of the Trilateral Cooperation on the Protection of the Wadden Sea

Annex 13

Agreement on the Conservation of Seals in the Wadden Sea according to Article 4 of the Convention on the Conservation of Migratory Species of Wild Animals (CMS, Bonn Convention), 1990

Agreement on the Conservation of Seals in the Wadden Sea, 1990

The Parties,

RECOGNIZING that seals are an irreplaceable component of the Wadden Sea ecosystem and that they are of great importance as indicators of its condition;

AWARE that they constitute a separate population whose main range and the main migration routes are located in the Wadden Sea and which should, as a consequence, be managed as a single unit;

DEEPLY CONCERNED by the conservation status of that population, which as the result of mass deaths of seals has been reduced to the lowest level ever recorded;

WITH A VIEW to improving this conservation status through concerted action on the part of the States that exercise jurisdiction over the range of that population;

RECALLING the Convention on the Conservation of Migratory Species of Wild Animals signed at Bonn on 23 June 1979 and notably its Appendix II which was amended in 1985 to include the Wadden Sea population of the common or harbour seal;

RECALLING the Joint Declaration on the Protection of the Wadden Sea, adopted at the Third Governmental Meeting on the Protection of the Wadden Sea in Copenhagen on 9 December 1982;

RECALLING the Declarations adopted by the First International Conference on the Protection of the North Sea, Bremen, 1 November 1984, and the Second International Conference on the Protection of the North Sea, London, 25 November 1987;

RECALLING the trilateral Administrative Agreement on a Common Secretariat for the Cooperation on the Protection of the Wadden Sea of 23 October 1987;

HAVE AGREED as follows:

I. Relationship with the Convention

This Agreement shall be deemed to be an agreement as defined in Article IV paragraph 4 of the Convention on the Conservation of Migratory Species of Wild Animals signed at Bonn on 23 June 1979.

II. Definitions

For the purpose of this Agreement:

a) "seal" means an animal of the species Phoca vitulina;

b) the "Agreement Area" means the area of water known as the Wadden Sea, including all sandbanks therein as well as all shore
areas of the North Sea coasts of Denmark, the Federal Republic of Germany and the Netherlands between Blaavandshuk to the
north and Den Helder to the west. The main ranges and the main migration routes are located in the Wadden Sea;

c) "seal population" means all seals which, at any time, are present in the Agreement Area;

d) "habitat" means any part of the Agreement Area which is essential to the maintenance of the vital biological functions of seals,
including but not limited to breeding, whelping, nursing, feeding or resting;

e) "Convention" means the Convention on the Conservation of Migratory Species of Wild Animals signed at Bonn on 23 June 1979;

f) the terms defined in Article I, sub-paragraphs 1 (a) to (d) and 1 (I) of the Convention shall have the same meaning in this
Agreement.

III. Purpose and Object

The Parties shall cooperate closely with a view to achieving and maintaining a favourable conservation status for the seal population.

IV. Conservation and Management Plan

The Parties shall develop on the basis of scientific knowledge a conservation and management plan for the seal population. This plan shall contain a comprehensive statement of actions which are or are to be undertaken by the Parties to achieve the goals of this Agreement. The Parties shall keep the plan under review and amend it, as may be required, taking into consideration, in particular, the results of scientific research.

V. Research and Monitoring

1. 1. The Parties shall co-ordinate their research programmes and projects and their monitoring of the seal population to increase their knowledge of the biology and the habitats including harmful effects of human activities on the seal population to provide a basis for measures to improve its conservation status.
2. 2. They shall, in particular, monitor and co-ordinate their research on,

a) population trends e.g. through periodic aerial surveys and counts;

b) seal migration;

c) seal population parameters, e.g. diseases, survival, age structure, sex ratio.

VI. Taking

1. 1. The Parties shall prohibit the taking of seals from the Wadden Sea.
2. 2. The competent authorities may grant exemptions from the prohibition referred to in the first paragraph authorizing persons to take seals:

- for institutions to be designated performing scientific research into the conservation of the seal population in the Wadden Sea or the conservation of the Wadden Sea ecosystem, insofar as the information required for such research cannot be obtained in any other way; or
- for institutions to be designated nursing seals in order to release them after recovery, insofar as these are diseased or weakened seals or evidently abandoned suckling seals.

Seals which are clearly suffering and cannot survive may be killed by the persons referred to in this paragraph.

1. 3. Any Party having granted exemptions as mentioned above shall notify the other Parties as soon as possible and provide them with an opportunity for review and comment.
2. 4. The Parties shall take appropriate action to suppress illegal hunting and taking of seals.

VII. Habitats

1. 1. The Parties shall take appropriate measures for the protection of habitats. They shall pay due regard to the necessity of creating and maintaining a network of protected areas also in the migration areas of the seals in the Agreement Area and of ensuring the preservation of areas which are essential to the maintenance of the vital biological functions of seals.
2. 2. The Parties shall preserve habitats and seals present from undue disturbances or changes resulting, directly or indirectly, from human activities.
3. 3. The Parties shall have regard to the protection of habitats from adverse effects resulting from activities carried out outside the Agreement Area.
4. 4. The Parties shall explore the possibility of restoring degraded habitats and of creating new ones.

VIII. Pollution

The Wadden Sea States are determined to do their utmost to further reduce pollution of the North Sea from whatever source with the aim of conserving and protecting the Agreement Area.

To this end they shall:

a) endeavour to identify the sources of such pollution;

b) co-ordinate their research projects regarding seal diseases and the effects on the seal population of

such substances, e. g. organochlorine compounds, heavy metals and oil, and agree on methods which permit a comparison of research results; c) monitor in the Agreement Area, in particular in seal tissues and in organisms which are preyed upon by seals, the levels of those substances which in the light of the results of research appear to play a major role in the conservation status of the seal population.

IX. Responsible Authorities

Each Party shall inform the other Parties of the authorities which shall be responsible for the implementation of this Agreement.

X. Public Awareness

The Parties shall take such measures as may be required to make the general public aware of the conservation status of the seal population, of the content and aims of this Agreement, and of the measures they have taken pursuant to this Agreement, including the Conservation and Management Plan, to improve this conservation status.

XI. Amendment of the Agreement

Any Party may propose amendments to this Agreement. Any such proposed amendment shall be submitted to the Depositary and communicated by it to all Parties, which shall inform the Depositary of their acceptance or rejection of the amendment as soon as possible after the receipt of the communication. The amendment shall enter into force ninety days after the Depositary has received notifications of acceptance of that amendment frcm all Parties.

XII. Effects on International Conventions and other Legislation

1. 1. The provisions of this Agreement shall in no way affect the rights or obligations of any Party deriving from any existing bilateral or multilateral convention.
2. 2. The provisions of this Agreement shall in no way affect the right of Parties to adopt stricter domestic measures concerning the conservation of seals.

XIII. Settlement of Disputes

1. 1. Any dispute which may arise between the Parties with respect to the interpretation or application of the provisions of this Agreement shall be subject to negotiation between the Parties involved in the dispute.
2. 2. If the dispute cannot be resolved in accordance with paragraph 1 of this Article within six months, the procedure provided for in the European Convention for the peaceful settlement of disputes of 29 April 1957 shall be followed.

XIV. Reservation

The provisions of this Agreement shall not be subject to reservations.

XV. Ratification, Acceptance, Approval

This Agreement shall be subject to ratification, acceptance or approval. Instruments of ratification, acceptance or approval shall be deposited with the Government of the Federal Republic of Germany,

which shall be the Depositary.

XVI. Entry into Force

This Agreement shall enter into force on the first day of the third month following the date of deposit of the third instrument of ratification, acceptance, approval or accession with the Depositary.

XVII. Denunciation

At any time, after the expiration of a period of five years from the date of entry into force of this Agreement, any Party may by written notice to the Depositary denounce this Agreement with effect from the end of a calendar year. This Agreement shall be terminated twelve months after the Depositary has received such notice.

XVIII. Depositary

1. 1. The original of this Agreement, in the Danish, Dutch, English and German languages, each version being equally authentic, shall be deposited with the Depositary. The Depositary shall transmit certified copies of each of these versions to the States which have signed the Agreement and the Secretariat of the Convention.
2. 2. The Depositary shall inform all signatory States and the Secretariat of the Convention of signatures, deposit of instruments of ratification, acceptance, approval or accession, entry into force of this Agreement, amendments thereto, and notices of denunciation.
3. 3. As soon as this Agreement enters into force, a certified copy thereof shall be transmitted by the Depositary to the Secretariat of the United Nations for registration and publication in accordance with Article 102 of the Charter of the United Nations, and to the Secretariat of the Convention.

IN WITNESS WHEREOF the undersigned, being duly authorized to that effect, have signed this Agreement.

DONE at Bonn on 16 October 1990

For the Government of the Kingdom of Denmark

For the Government of the Federal Republic of Germany

For the Government of the Kingdom of the Netherlands

Annex 14

Designation of the Wadden Sea as Particularly Sensitive Sea Area (PSSA) by the International Maritime Organization, 2002

INTERNATIONAL MARITIME ORGANIZATION

IMO

E

MARINE ENVIRONMENT PROTECTION COMMITTEE
48th session
Agenda item 21

MEPC 48/21
24 October 2002
Original: ENGLISH

REPORT OF THE MARINE ENVIRONMENT PROTECTION COMMITTEE ON ITS FORTY-EIGHTH SESSION

ANNEXES

7 IDENTIFICATION AND PROTECTION OF SPECIAL AREAS AND PARTICULARLY SENSITIVE SEA AREAS

Draft Guidance document for submission of PSSA proposals

7.1 The Committee recalled that, at MEPC 45, when developing the Guidelines for the Identification and Designation of Particularly Sensitive Sea Areas, it agreed that some guidance on how to select the most appropriate regime for a given area of sea to be protected could be included in a supplementary document to the Guidelines.

7.2 The Committee also recalled that MEPC 47, in considering a document by the United States (MEPC 47/8/1) providing guidance to Member States, supported it in principle. However, MEPC 47 agreed that certain modifications should be made to it and the Secretariat was instructed to prepare a draft MEPC circular, based on the United States document for approval by the Committee at this session.

7.3 The Committee, having noted that the Secretariat had made changes to the draft MEPC circular "Guidance Document for Submission of PSSA Proposals to IMO" (MEPC 48/7/1) as instructed by MEPC 47 (MEPC 47/20, paragraph 8.18), agreed that it would be useful to appendix to the document a framework of what needs to be included in a proposal. The Committee requested the Secretariat to prepare the text of the appendix, using the headings and sub-headings of the Florida Key PSSA proposal submission (MEPC 46/6/2), which MEPC 46 agreed should serve as a model by Member States when proposing their PSSAs. Reference of the original document should be given.

7.4 In considering the draft MEPC Circular (MEPC 48/7/1), the Committee agreed to issue the Guidance Document with its appendix to be prepared by the Secretariat as MEPC/Circ.398.

Establishment of an Informal Group for reviewing PSSA and Special Area proposals

7.5 The Committee noted that there is a need for a mechanism to review PSSA and Special Area proposals to ensure that they meet the requirements of the Guidelines for identifying and designating PSSAs and for designating Special Areas (resolution A.927(22)).

7.6 The Committee recognized that, with the expected increase of new PSSA proposals being put forward to this Committee and given the limitation in the number of working groups allowed during any MEPC session, it is unrealistic to establish a MEPC working group every time when a new PSSA or a Special Area proposal is submitted.

7.7 The Committee agreed with the Chairman's proposal to establish an Informal Group under the chairmanship of Mr. Paul Nelson (Australia) to:

.1 review the proposals for the marine area of the Paracas National Reserve and for the Wadden Sea to be designated as Particularly Sensitive Sea Areas (PSSAs) (MEPC 48/7 and MEPC 48/7/2), to determine whether they meet the provisions of the Guidelines for the Identification and Designation of Particularly Sensitive Sea Areas (Annex 2 of resolution A.927(22));

.2 review the proposal to extend the "Gulfs area" as a Special Area under Annexes I and V of MARPOL 73/78, (MEPC 48/7/3 and MEPC 48/7/3/Corr.1), to

determine whether it meets the provisions of the Guidelines for the Designation of Special Areas under MARPOL 73/78 (Annex 1 of resolution A.927(22)); and

.3 provide a written report to the plenary outlining its findings.

Report of the Informal Working Group

7.8 The Committee, having received the report of the Group (MEPC 48/WP.14), noted the following:

.1 the Group examined each proposal against a checklist with 46 questions for PSSAs and 18 questions for Special Areas, covering all the criteria set out in resolution A.927(22);

.2 the Group reviewed the joint submission by Denmark, Germany and the Netherlands for the Wadden Sea to be designated as a PSSA (MEPC 48/7/2), and agreed that the submission included information on all applicable criteria, and that this information satisfied the requirements of those criteria. The Group recommended that, as IMO measures already exist to protect this area and there are no new measures requiring referral to any other Committee or Sub-Committee, MEPC take appropriate steps to designate the area as a PSSA;

.3 the Group reviewed the proposal by Peru for the Paracas National Reserve to be designated as a PSSA (MEPC 48/7) and agreed that all environmental criteria were satisfied. In response to concerns expressed by the Group regarding the need for more information on some criteria, in particular on the volume of traffic and hazardous cargoes, Peru provided additional information (annex 2 of MEPC 48/WP.14). The Group determined that this information satisfied the relevant criteria;

.4 the Group in considering the two associated protective measures proposed by Peru, namely an Area to be Avoided and a “no discharge” area, recommended that the Area to be Avoided should be referred to the NAV Sub-Committee for review. As regards the proposed “no discharge” area, prohibiting any kind of discharge from ships, the Group determined that the information provided was not sufficient to justify the approval of such an area at this session of the Committee;

.5 accordingly, in accordance with the Guidelines, the Group recommended that the Committee approve the Paracas National Reserve PSSA, in principle, pending consideration of the proposal for an Area to be Avoided by the NAV Sub-Committee on the basis of a separate submission by Peru;

.6 the Group noted the submission by Oman for the extension of the "Gulfs area" as a Special Area under Annexes I and V of MARPOL 73/78. Additional information on proposed amendments to MARPOL 73/78 and a chart, which are attached at annex 3 to MEPC 48/WP.14, as well as information provided orally to the Group, was provided by the delegation of Oman; and

.7 the Group agreed that further information was required to show that the discharge of garbage from ships, when operating in accordance with MARPOL 73/78, was a particular threat. Accordingly, the Group determined that the submission satisfies the requirements for Special Area status in respect of Annex I, but not Annex V of

MARPOL 73/78. The Group therefore recommended that the Oman Area of the Arabian Sea be designated as a Special Area under Annex I of MARPOL 73/78, as defined in the submission and annex 3 to document MEPC 48/WP.14, and that such Special Area would be distinct from the "Gulfs area" Special Area since it is in the Arabian Sea and outside the "Gulfs area".

Report of the Informal Working Group

7.9 Having considered the report of the Informal Working Group (MEPC 48/WP.14), the Committee:

.1 designated the Wadden Sea as a PSSA through the adoption of resolution MEPC.101(48), as attached at annex 5;

.2 referred the proposal for an Area to be avoided in the Paracas National Reserve to the NAV Sub-Committee for consideration;

.3 approved, in principle, the designation of Paracas National Reserve as a PSSA, pending consideration of the proposal for an Area to be Avoided by the NAV Sub-Committee; and

.4 approved the proposed amendments to MARPOL Annex I, with a view to designating the Oman area of the Arabian Sea as a Special Area under MARPOL Annex I, as set out in annex 6 and requested the Secretary-General to circulate the proposed amendments for adoption at MEPC 49.

ANNEX 5

RESOLUTION MEPC.101 (48)

Adopted on 11 October 2002

IDENTIFICATION OF THE WADDEN SEA AS A PARTICULARLY SENSITIVE SEA AREA

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

BEING AWARE of the ecological, social, economic, cultural, scientific and educational value of the Wadden Sea, as well as its vulnerability to damage by international shipping traffic and activities in the area and the steps taken by Denmark, Germany and the Netherlands to address that vulnerability,

NOTING that the Guidelines for the Identification and Designation of Particularly Sensitive Sea Areas adopted under resolution A.927(22) set out procedures for the designation of particularly sensitive sea areas,

HAVING CONSIDERED the proposal from Denmark, Germany and the Netherlands to designate the Wadden Sea as a Particularly Sensitive Sea Area,

HAVING AGREED that criteria for identification of a Particularly Sensitive Sea Area provided in resolution A.927(22) are fulfilled for the Wadden Sea,

1. DESIGNATES the Wadden Sea as defined in Annexes 1, 2 and 3 to this resolution as a Particularly Sensitive Sea Area.

ANNEX 1

DESCRIPTION OF THE PARTICULARLY SENSITIVE SEA AREA
WADDEN SEA CO-ORDINATES

a. Description

In order to avoid the risk of pollution and damage to this exceptional, highly dynamic tidal ecosystem of world importance, mariners should exercise extreme care when navigating in the area bounded by a line connecting the following geographical positions which is designated as a Particularly Sensitive Sea Area and in the adjacent area:

The PSSA Wadden Sea is bordered:

Seawards: by an offshore line defined by a set of geographical co-ordinates (see co-ordinates listed under c.),

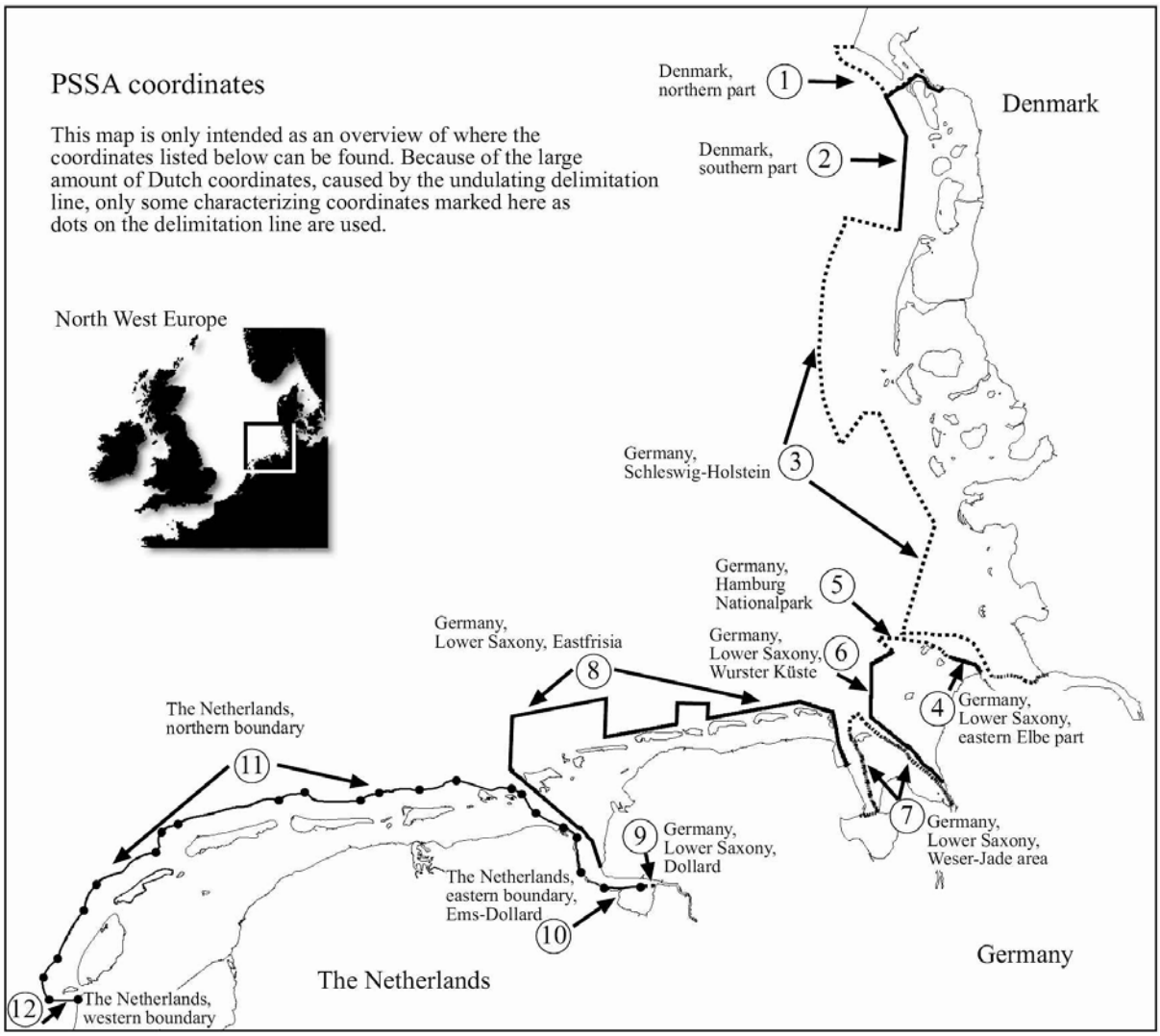
Landwards: by the main dikes, or where the main dikes are absent, by the spring-high-tide-water line, and in the rivers, by the brackish-water limit.

The inhabited islands are excluded from the PSSA. These islands are in:

Denmark:	Rømø, Mandø, Fanø
Germany:	
Schleswig-Holstein:	Pellworm, Nordstrandischmoor, Hooge, Gröde, Langeneß-Oland, Föhr, Amrum, Sylt, Norderoog, Habel, Süderoog
Hamburg:	Neuwerk
Lower Saxony:	Borkum, Juist, Norderney, Baltrum, Langeoog, Spiekeroog, Wangerooge
The Netherlands:	Texel, Vlieland, Terschelling, Ameland, Schiermonnikoog

b. Illustrative overview

The illustrative overview shows the different parts (1-12) of the offshore line of the proposed PSSA Wadden Sea. The numbers and names pointing to the different parts refer to the list of co-ordinates given in the tables under c.



c. List of geographical co-ordinates (projection WGS84) for the bordering offshore line of the proposed PSSA Wadden Sea

Denmark

The proposed PSSA in the Danish Wadden Sea is divided into a northern part and a southern part by the Esbjerg Harbour shipping lane and the outer area of Esbjerg Harbour.

Northern part (1)

The PSSA delimitation consists of 28 points with the following coordinates from Blaavandshuk to the shore north of Esbjerg Harbour.

Southern part (2)

The PSSA delimitation consists of 17 points with the following coordinates, from the shore south of Esbjerg Harbour to the borderline between Denmark and Germany territorial waters.

1 Denmark, northern part

No.	East	North
1	8° 04,516'	55° 33,463'
2	7° 59,00'	55° 33,48'
3	7° 59,02'	55° 33,21'
4	7° 59,06'	55° 32,99'
5	7° 59,16'	55° 32,74'
6	7° 59,28'	55° 32,50'
7	7° 59,45'	55° 32,28'
8	7° 59,67'	55° 32,04'
9	7° 59,89'	55° 31,83'
10	8° 00,15'	55° 31,62'
11	8° 00,47'	55° 31,43'
12	8° 00,82'	55° 31,26'
13	8° 01,21'	55° 31,10'
14	8° 01,57'	55° 30,95'
15	8° 01,94'	55° 30,82'
16	8° 02,34'	55° 30,71'
17	8° 08,12'	55° 29,23'
18	8° 10,46'	55° 28,14'
19	8° 11,96'	55° 27,38'
20	8° 13,716'	55° 25,593'
21	8° 16,879'	55° 26,916'
22	8° 18,104'	55° 27,228'
23	8° 19,357'	55° 27,873'
24	8° 20,793'	55° 28,608'
25	8° 21,791'	55° 29,056'
26	8° 21,915'	55° 29,109'
27	8° 22,724'	55° 29,467'
28	8° 23,635'	55° 29,866'

2 Denmark, southern part

No.	East	North
29	8° 30,157'	55° 27,166'
30	8° 28,490'	55° 26,420'
31	8° 25,620'	55° 27,160'
32	8° 24,904'	55° 27,866'
33	8° 24,574'	55° 28,273'
34	8° 24,151'	55° 28,614'
35	8° 22,436'	55° 28,975'
36	8° 21,929'	55° 28,776'
37	8° 21,043'	55° 28,452'
38	8° 19,581'	55° 27,724'
39	8° 18,195'	55° 27,046'
40	8° 17,016'	55° 26,805'
41	8° 13,825'	55° 25,470'
42	8° 14,080'	55° 25,220'
43	8° 19,543'	55° 19,100'
44	8° 18,900'	55° 12,300'
45	8° 18,040'	55° 03,795'

Germany

Below are the coordinates for the seven parts (3-9) representing the delimitation of the proposed PSSA for Germany.

3 Germany, Schleswig-Holstein

No.	East	North
46	8° 18,040'	55° 03,795'
47	8° 02,716'	55° 06,053'
48	8° 02,618'	55° 05,647'
49	8° 02,547'	55° 05,239'
50	8° 02,395'	55° 05,011'
51	8° 01,635'	55° 03,814'
52	8° 00,960'	55° 02,982'
53	8° 00,708'	55° 02,659'
54	8° 00,471'	55° 02,332'
55	7° 59,598'	55° 01,064'
56	7° 59,354'	55° 00,692'
57	7° 59,133'	55° 00,319'
58	7° 58,572'	54° 59,317'
59	7° 58,493'	54° 59,170'
60	7° 57,853'	54° 57,968'
61	7° 57,640'	54° 57,540'
62	7° 57,451'	54° 57,102'
63	7° 57,292'	54° 56,660'
64	7° 57,032'	54° 55,858'
65	7° 56,876'	54° 55,303'
66	7° 56,765'	54° 54,745'
67	7° 56,591'	54° 53,645'
68	7° 56,531'	54° 53,169'
69	7° 56,429'	54° 52,013'
70	7° 56,279'	54° 50,539'
71	7° 56,253'	54° 50,166'
72	7° 56,209'	54° 49,265'
73	7° 56,203'	54° 48,945'
74	7° 56,209'	54° 48,625'
75	7° 56,234'	54° 48,095'
76	7° 56,218'	54° 47,848'
77	7° 55,986'	54° 46,380'
78	7° 55,921'	54° 45,823'
79	7° 55,899'	54° 45,265'
80	7° 55,925'	54° 44,707'
81	7° 55,995'	54° 44,148'
82	7° 56,732'	54° 39,682'
83	7° 56,800'	54° 39,104'
84	7° 56,918'	54° 38,529'
85	7° 57,083'	54° 37,957'
86	7° 57,295'	54° 37,390'
87	7° 57,556'	54° 36,830'
88	7° 57,674'	54° 36,597'
89	7° 57,920'	54° 36,145'
90	7° 58,197'	54° 35,697'
91	7° 58,505'	54° 35,257'
92	8° 02,338'	54° 30,063'
93	8° 08,522'	54° 35,126'
94	8° 15,406'	54° 35,126'
95	8° 17,071'	54° 32,932'
96	8° 18,308'	54° 31,208'
97	8° 19,144'	54° 30,053'
98	8° 19,462'	54° 29,614'
99	8° 20,191'	54° 28,596'

3 Germany, Schleswig-Holstein

No.	East	North
100	8° 20,996'	54° 27,489'
101	8° 21,858'	54° 26,289'
102	8° 22,692'	54° 25,140'
103	8° 22,956'	54° 24,747'
104	8° 23,091'	54° 24,545'
105	8° 23,624'	54° 23,878'
106	8° 25,125'	54° 22,186'
107	8° 26,205'	54° 20,980'
108	8° 28,843'	54° 18,099'
109	8° 25,467'	54° 13,309'
110	8° 23,782'	54° 10,917'
111	8° 20,322'	54° 06,008'
112	8° 20,305'	54° 05,983'
113	8° 17,718'	54° 02,317'
114	8° 17,689'	54° 02,275'
115	8° 16,859'	54° 01,099'
116	8° 16,056'	53° 59,960'
117	8° 28,660'	53° 59,936'
118	8° 28,725'	53° 59,940'
119	8° 28,826'	53° 59,940'
120	8° 28,937'	53° 59,937'
121	8° 29,048'	53° 59,941'
122	8° 29,133'	53° 59,942'
123	8° 29,221'	53° 59,948'
124	8° 29,344'	53° 59,954'
125	8° 29,410'	53° 59,952'
126	8° 29,486'	53° 59,947'
127	8° 29,584'	53° 59,938'
128	8° 29,691'	53° 59,930'
129	8° 29,788'	53° 59,923'
130	8° 29,871'	53° 59,911'
131	8° 29,965'	53° 59,905'
132	8° 30,068'	53° 59,907'
133	8° 30,156'	53° 59,905'
134	8° 30,252'	53° 59,910'
135	8° 30,337'	53° 59,910'
136	8° 30,393'	53° 59,912'
137	8° 30,457'	53° 59,913'
138	8° 30,523'	53° 59,917'
139	8° 30,585'	53° 59,921'
140	8° 30,658'	53° 59,924'
141	8° 30,725'	53° 59,930'
142	8° 30,779'	53° 59,932'
143	8° 30,837'	53° 59,929'
144	8° 30,946'	53° 59,930'
145	8° 31,057'	53° 59,942'
146	8° 31,148'	53° 59,953'
147	8° 31,276'	53° 59,965'
148	8° 31,372'	53° 59,969'
149	8° 31,475'	53° 59,972'
150	8° 31,559'	53° 59,977'
151	8° 31,638'	53° 59,982'
152	8° 31,691'	53° 59,990'
153	8° 31,759'	54° 00,005'

3 Germany, Schleswig-Holstein

No.	East	North
154	8° 31,833'	54° 00,008'
155	8° 31,951'	54° 00,016'
156	8° 32,046'	54° 00,021'
157	8° 32,156'	54° 00,021'
158	8° 32,250'	54° 00,021'
159	8° 32,348'	54° 00,021'
160	8° 32,441'	54° 00,024'
161	8° 32,528'	54° 00,023'
162	8° 32,613'	54° 00,016'
163	8° 32,694'	54° 00,013'
164	8° 32,750'	54° 00,013'
165	8° 32,817'	54° 00,014'
166	8° 32,869'	54° 00,013'
167	8° 32,988'	54° 00,016'
168	8° 33,090'	54° 00,022'
169	8° 33,183'	54° 00,022'
170	8° 33,280'	54° 00,021'
171	8° 33,402'	54° 00,022'
172	8° 33,502'	54° 00,019'
173	8° 33,608'	54° 00,013'
174	8° 33,680'	54° 00,005'
175	8° 33,764'	53° 60,000'
176	8° 33,856'	53° 59,994'
177	8° 33,916'	53° 59,990'
178	8° 34,007'	53° 59,985'
179	8° 34,090'	53° 59,977'
180	8° 34,167'	53° 59,968'
181	8° 34,249'	53° 59,965'
182	8° 34,389'	53° 59,948'
183	8° 34,470'	53° 59,937'
184	8° 34,580'	53° 59,913'
185	8° 34,648'	53° 59,903'
186	8° 34,717'	53° 59,885'
187	8° 34,872'	53° 59,827'
188	8° 34,980'	53° 59,793'
189	8° 35,105'	53° 59,764'
190	8° 35,179'	53° 59,746'
191	8° 35,253'	53° 59,729'
192	8° 35,329'	53° 59,709'
193	8° 35,404'	53° 59,690'
194	8° 35,465'	53° 59,677'
195	8° 35,534'	53° 59,667'
196	8° 35,699'	53° 59,630'
197	8° 35,767'	53° 59,611'
198	8° 35,919'	53° 59,580'
199	8° 36,115'	53° 59,535'
200	8° 36,254'	53° 59,504'
201	8° 36,361'	53° 59,480'
202	8° 36,443'	53° 59,460'
203	8° 36,574'	53° 59,431'
204	8° 36,741'	53° 59,391'
205	8° 36,879'	53° 59,354'
206	8° 37,001'	53° 59,324'
207	8° 37,095'	53° 59,306'

3 Germany, Schleswig-Holstein

No.	East	North
208	8° 37,171'	53° 59,289'
209	8° 37,319'	53° 59,250'
210	8° 37,403'	53° 59,226'
211	8° 37,546'	53° 59,189'
212	8° 37,657'	53° 59,160'
213	8° 37,780'	53° 59,111'
214	8° 37,947'	53° 59,046'
215	8° 38,173'	53° 58,964'
216	8° 38,333'	53° 58,907'
217	8° 38,496'	53° 58,850'
218	8° 38,868'	53° 58,691'
219	8° 39,105'	53° 58,442'
220	8° 39,598'	53° 57,962'
221	8° 40,199'	53° 57,371'
222	8° 40,267'	53° 57,299'
223	8° 40,749'	53° 56,812'
224	8° 41,362'	53° 56,204'
225	8° 41,924'	53° 55,648'
226	8° 42,487'	53° 55,094'
227	8° 42,595'	53° 54,996'
228	8° 42,861'	53° 54,745'
229	8° 43,118'	53° 54,445'
230	8° 43,361'	53° 54,164'
231	8° 43,529'	53° 53,970'
232	8° 43,634'	53° 53,859'
233	8° 44,022'	53° 53,402'
234	8° 44,096'	53° 53,300'
235	8° 44,185'	53° 53,302'
236	8° 44,265'	53° 53,313'
237	8° 44,347'	53° 53,318'
238	8° 44,443'	53° 53,318'
239	8° 44,514'	53° 53,316'
240	8° 44,591'	53° 53,312'
241	8° 44,681'	53° 53,308'
242	8° 44,744'	53° 53,305'
243	8° 44,818'	53° 53,293'
244	8° 44,898'	53° 53,278'
245	8° 44,962'	53° 53,271'
246	8° 45,039'	53° 53,264'
247	8° 45,121'	53° 53,247'
248	8° 45,196'	53° 53,241'
249	8° 45,272'	53° 53,235'
250	8° 45,356'	53° 53,231'
251	8° 45,475'	53° 53,235'
252	8° 45,570'	53° 53,239'
253	8° 45,699'	53° 53,250'
254	8° 45,789'	53° 53,252'
255	8° 45,896'	53° 53,255'
256	8° 45,984'	53° 53,270'
257	8° 46,057'	53° 53,286'
258	8° 46,142'	53° 53,297'
259	8° 46,226'	53° 53,297'
260	8° 46,292'	53° 53,297'
261	8° 46,348'	53° 53,292'

3 Germany, Schleswig-Holstein

No.	East	North
262	8° 46,487'	53° 53,315'
263	8° 46,591'	53° 53,333'
264	8° 46,675'	53° 53,340'
265	8° 46,792'	53° 53,363'
266	8° 46,886'	53° 53,386'
267	8° 46,950'	53° 53,397'
268	8° 47,009'	53° 53,412'
269	8° 47,071'	53° 53,415'
270	8° 47,158'	53° 53,421'
271	8° 47,267'	53° 53,430'
272	8° 47,354'	53° 53,433'
273	8° 47,428'	53° 53,442'
274	8° 47,509'	53° 53,461'
275	8° 47,608'	53° 53,474'
276	8° 47,675'	53° 53,478'
277	8° 47,796'	53° 53,481'
278	8° 47,884'	53° 53,483'
279	8° 47,954'	53° 53,493'
280	8° 48,013'	53° 53,505'
281	8° 48,075'	53° 53,523'
282	8° 48,124'	53° 53,535'
283	8° 48,197'	53° 53,538'
284	8° 48,284'	53° 53,538'
285	8° 48,367'	53° 53,542'
286	8° 48,438'	53° 53,543'
287	8° 48,474'	53° 53,542'
288	8° 48,554'	53° 53,545'
289	8° 48,613'	53° 53,548'
290	8° 48,688'	53° 53,550'
291	8° 48,775'	53° 53,546'
292	8° 48,893'	53° 53,531'
293	8° 48,987'	53° 53,515'
294	8° 49,064'	53° 53,501'
295	8° 49,153'	53° 53,484'
296	8° 49,260'	53° 53,470'
297	8° 49,326'	53° 53,468'
298	8° 49,399'	53° 53,465'
299	8° 49,472'	53° 53,464'
300	8° 49,552'	53° 53,454'
301	8° 49,653'	53° 53,442'
302	8° 49,741'	53° 53,419'
303	8° 49,784'	53° 53,406'
304	8° 49,890'	53° 53,375'
305	8° 49,942'	53° 53,366'
306	8° 50,017'	53° 53,355'
307	8° 50,107'	53° 53,338'
308	8° 50,172'	53° 53,318'
309	8° 50,287'	53° 53,308'
310	8° 50,382'	53° 53,302'
311	8° 50,449'	53° 53,306'
312	8° 50,553'	53° 53,314'
313	8° 50,617'	53° 53,316'
314	8° 50,684'	53° 53,313'
315	8° 50,776'	53° 53,302'

3 Germany, Schleswig-Holstein

No.	East	North
316	8° 50,831'	53° 53,298'
317	8° 50,914'	53° 53,288'
318	8° 50,994'	53° 53,278'
319	8° 51,087'	53° 53,269'
320	8° 51,167'	53° 53,263'
321	8° 51,271'	53° 53,253'
322	8° 51,350'	53° 53,236'
323	8° 51,433'	53° 53,218'
324	8° 51,484'	53° 53,209'
325	8° 51,584'	53° 53,184'
326	8° 51,659'	53° 53,164'
327	8° 51,753'	53° 53,137'
328	8° 51,831'	53° 53,119'
329	8° 51,910'	53° 53,105'
330	8° 51,976'	53° 53,085'
331	8° 52,042'	53° 53,066'
332	8° 52,133'	53° 53,035'
333	8° 52,201'	53° 52,992'
334	8° 52,241'	53° 52,963'
335	8° 52,273'	53° 52,942'
336	8° 52,317'	53° 52,921'
337	8° 52,412'	53° 52,884'
338	8° 52,478'	53° 52,852'
339	8° 52,557'	53° 52,821'
340	8° 52,646'	53° 52,792'
341	8° 52,711'	53° 52,767'
342	8° 52,792'	53° 52,737'
343	8° 52,868'	53° 52,716'
344	8° 52,987'	53° 52,670'
345	8° 53,078'	53° 52,645'
346	8° 53,161'	53° 52,623'
347	8° 53,276'	53° 52,591'
348	8° 53,366'	53° 52,564'
349	8° 53,482'	53° 52,524'
350	8° 53,544'	53° 52,498'
351	8° 53,660'	53° 52,459'
352	8° 53,736'	53° 52,440'
353	8° 53,813'	53° 52,410'
354	8° 53,901'	53° 52,377'
355	8° 53,937'	53° 52,364'
356	8° 54,071'	53° 52,327'
357	8° 54,156'	53° 52,311'
358	8° 54,231'	53° 52,283'
359	8° 54,333'	53° 52,256'
360	8° 54,430'	53° 52,233'
361	8° 54,506'	53° 52,207'
362	8° 54,587'	53° 52,182'
363	8° 54,629'	53° 52,162'
364	8° 54,719'	53° 52,142'
365	8° 54,787'	53° 52,144'
366	8° 54,923'	53° 52,111'
367	8° 55,032'	53° 52,091'
368	8° 55,127'	53° 52,067'
369	8° 55,256'	53° 52,034'

3 Germany, Schleswig-Holstein

No.	East	North
370	8° 55,373'	53° 52,008'
371	8° 55,476'	53° 51,989'
372	8° 55,543'	53° 52,011'
373	8° 55,599'	53° 52,035'
374	8° 55,641'	53° 52,062'

4 Germany, Lower Saxony, eastern Elbe part

No.	East	North
375	8° 41,200'	53° 53,533'
376	8° 39,550'	53° 54,917'
377	8° 32,150'	53° 56,167'

5 Germany, Hamburg National park

No.	East	North
378	8°30,25’	53°57,42’
379	8°26,31‘	53°58,36’
380	8°21,93‘	53°58,76’
381	8°18,90‘	53°59,02’
382	8°13,17’	53°59,02’
383	8°12,77’	53°58,88’
384	8°17,43’	53°56,99’

6 Germany, Lower Saxony, Wurster Küste

No.	East	North
385	8° 11,533'	53° 54,900'
386	8° 11,533'	53° 53,200'
387	8° 11,533'	53° 46,417'
388	8° 20,150'	53° 42,333'
389	8° 23,583'	53° 40,683'
390	8° 27,683'	53° 38,133'
391	8° 30,683'	53° 36,300'

7 Germany, Lower Saxony, Weser-Jade area

No.	East	North
392	8° 32,883'	53° 32,317'
393	8° 33,317'	53° 32,400'
394	8° 28,667'	53° 36,750'
395	8° 20,617'	53° 41,183'
396	8° 14,433'	53° 43,317'
397	8° 09,917'	53° 45,483'
398	8° 07,950'	53° 46,967'
399	8° 05,583'	53° 45,933'
400	8° 05,583'	53° 43,717'
401	8° 09,050'	53° 40,217'
402	8° 11,817'	53° 33,283'
403	8° 13,600'	53° 31,217'
404	8° 09,950'	53° 30,717'
405	8° 08,717'	53° 30,650'

8 Germany, Lower Saxony, Eastfrisia

No.	East	North
406	8° 05,100'	53° 38,667'
407	8° 05,483'	53° 38,783'
408	8° 04,583'	53° 39,850'
409	8° 02,817'	53° 41,900'
410	8° 01,850'	53° 45,383'
411	8° 01,067'	53° 47,133'
412	7° 52,350'	53° 48,700'
413	7° 27,383'	53° 45,800'
414	7° 27,383'	53° 48,217'
415	7° 19,083'	53° 48,217'
416	7° 19,083'	53° 44,750'
417	7° 00,000'	53° 42,300'
418	7° 00,000'	53° 45,400'
419	7° 00,000'	53° 48,733'
420	6° 34,850'	53° 45,183'
421	6° 34,850'	53° 41,900'
422	6° 34,850'	53° 38,000'
423	6° 34,850'	53° 37,050'
424	6° 35,750'	53° 36,350'
425	6° 42,850'	53° 33,033'
426	6° 52,817'	53° 28,167'
427	6° 54,917'	53° 27,583'
428	6° 56,117'	53° 26,567'
429	6° 57,633'	53° 25,900'
430	6° 59,450'	53° 22,800'

9 Germany, Lower Saxony, Dollard

No.	East	North
431	7° 14,910'	53° 19,087'
432	7° 11,513'	53° 18,863'

The Netherlands

Below are the co-ordinates representing the delimitation of the proposed PSSA for the Netherlands.

- Point 433 until 440 represent the eastern boundary, Ems Dollard, of the area (part 10).
- Point 441 until 453 represent the delimitation of the northern part of the area. It consists of the three nautical miles line from the baseline. Because this is a curved line, there are at least 1900 coordinates, but only some characterizing coordinates have been listed below. The map in annex 2 has been compiled on the basis of detailed information on the 3 nautical miles line (available from the *Dienst der Hydrografie*, the Hydrographical Service in the Hague, Netherlands) (part 11).
- Point 454 and 455 represent the western boundary of the area. It is the line from Den Helder towards the West, crossing the three nautical miles line (part 12).

10 The Netherlands, eastern boundary, Ems-Dollard

No.	East	North
433	7° 11,605'	53° 18,882'
434	7° 00,666'	53° 18,655'
435	6° 54,414'	53° 20,860'
436	6° 53,420'	53° 26,439'
437	6° 50,010'	53° 27,797'
438	6° 41,803'	53° 30,069'
439	6° 37,214'	53° 33,289'
440	6° 35,685'	53° 33,688'

11 The Netherlands, northern boundary

No.	East	North
441	6° 20,487'	53° 34,798'
442	6° 14,347'	53° 33,356'
443	6° 00,295'	53° 32,295'
444	5° 55,497'	53° 31,964'
445	5° 40,285'	53° 31,769'
446	5° 33,542'	53° 30,412'
447	5° 06,734'	53° 25,551'
448	5° 02,336'	53° 24,218'
449	5° 01,358'	53° 21,138'
450	4° 45,087'	53° 14,785'
451	4° 43,325'	53° 11,133'
452	4° 37,086'	53° 03,145'
453	4° 33,291'	52° 59,296'

12 The Netherlands, western boundary

No.	East	North
454	4° 43,056'	52° 56,841'
455	4° 35,221'	52° 56,564'

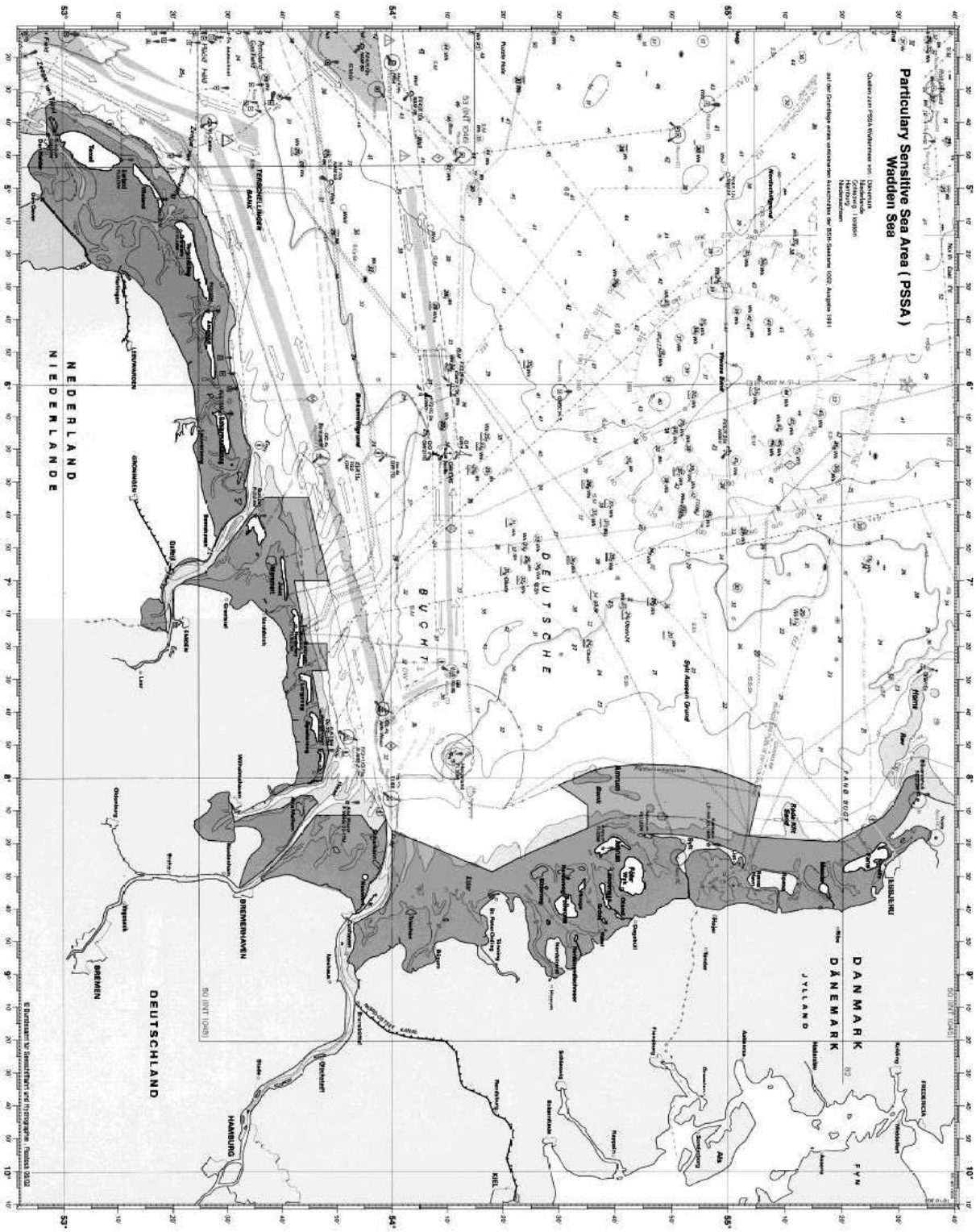
ANNEX 2

PSSA CHART
PROPOSED PARTICULARLY SENSITIVE SEA AREA

WADDEN SEA BOUNDARY

Reference: Nautical chart from Bundesamt für Seeschifffahrt und Hydrographie, BSH, Germany. Nautical chart 1002, Edition 1991

[Coloured copies of the chart will be distributed at the meeting.]



ANNEX 3

EXISTING MEASURES

Measures adopted by IMO and at the national and EC levels

I General measures

IMO measures

The IMO has issued numerous conventions to improve maritime safety and prevent pollution from ships, for example the International Regulations for Preventing Collisions at Sea, 1972 (as amended by Resolutions A.464 (XII), A.626 (15), A.678 (16) and A.736 (18)), COLREGs and SOLAS V.

EC measures

Also the European Union has already issued numerous Directives corresponding to IMO measures, including e.g. directives on port State control, marine equipment, notification obligations, and on the management of ship generated waste and cargo residues. These are continually being updated and implemented into national legislation.

According to the EC Habitat Directive (Council Directive 92/43/EEC) and the EC Bird Directive (Council Directive 79/409/EEC) Member States shall list areas of Community Interest respectively Special Protection Areas. These areas constitute the Natura 2000 network. Basically, the Wadden Sea, until 3 sea miles offshore except for the main shipping routes, has been listed as habitat areas according to the Habitat Directive and as Special Protection Areas according to the Bird Directive.

Other regional measures

Radio navigational warnings contain information that directly affects safety of life at sea and the protection of the environment. They are issued by NAVTEX, MRCC's, VTS centers or other services.

Bilateral (NL & D) Local Rules and Traffic Regulations for the Ems estuary.

NATIONAL MEASURES

Denmark	Germany	Netherlands
♦ Ministerial order on transfer of bunkers in the Danish territorial sea.	♦ **Regulations on the navigation of Federal waterways in national parks in the North Sea area.** ♦ Navigable Waterways Ordinance ♦ VTS available in certain areas. ♦ **Pilotage services and Deep Sea Pilotage Services available for various ports and areas.** ♦ Modern aids to navigation (AIS, GPS, buoyage, lighthouses). ♦ SAR and MRCC services available. ♦ Emergency towing capacity available. ♦ Deep Sea Pilotage Services available. ♦ Agreement with private companies on keeping helicopter capacity in reserve to permit action to be taken swiftly in the case of emergencies and accidents at sea.	♦ **Additional Local Rules and Regulations (BPR, "Scheepvaartreglement Territoriale Zee" (STZ)).** ♦ VTS available in certain areas. ♦ Pilotage services available for various ports. ♦ Communication facilities available. ♦ Differential GPS available. ♦ Buoyage available in entire area. ♦ Lighthouses available on all major islands and along the mainland coastline. ♦ SAR services available. ♦ Salvage tugs available. Powerful salvage tug (m.s. "WAKER") stand-by. ♦ Deep Sea Pilotage Services available. ♦ Numerous RACONs are available on (offshore) platforms and buoys.

II Collision avoidance, navigation, routing measures

IMO measures

IMO routeing schemes are in place in the North Sea to simplify traffic flows to reduce the collision hazard and to keep ships carrying certain dangerous or polluting goods away from the Wadden Sea coast. Traffic Separation Schemes in the concerned area adopted by the IMO are:

- At West Hinder
- Off Botney Ground
- East Friesland
- North Hinder
- Off Texel
- Jade Approach
- Terschelling-German Bight
- Off Brown Ridge
- West Friesland
- Off Friesland
- Off Vlieland,Vlieland North and Friesland Junction
- In the approaches to Hook of Holland
- German Bight Western Approach
- In the approaches to river Elbe

The Deep-Water Route and Traffic Separation Scheme (TSS) from North Hinder to the German Bight via the Frisian Junction, is mandatory for the following classes of ships:

- Tankers of 10,000 GT + carrying oils as defined under Annex 1 of MARPOL 73/78;
- Ships of 5,000 GT+ carrying noxious liquid substances in bulk categories A or B of Annex II of MARPOL 73/78;
- Ships of 10,000 GT+ carrying noxious liquid substances in bulk categories C or D of Annex II of MARPOL 73/78; and
- Ships of 10,000 GT + carrying liquefied gases in bulk.

EC measures

Reference to paragraph V.

Other regional measures

None.

National measures

None.

III Pilotage, port entry and departure

IMO measures

Ships using the mandatory route for tankers from the North Hinder to the German Bight are recommended to use adequately qualified deep-sea pilots in the North Sea.

EC measures

European Directive 93/75/EEC requires the Master and Operator of vessels carrying dangerous or polluting goods to report cargo details entering or leaving EC ports.

Dangerous goods are defined in:

- *The International Maritime Dangerous Goods (IMDG) Code*
- *The International Gas Carrier (IGC) Code*
- *The International Bulk Carrier (IBC) Code*

Polluting goods are defined in MARPOL Annexes I, II & III.

European Directive 95/21/EEC (Port State Control)

Other regional measures

None.

NATIONAL MEASURES

Denmark	***Germany***	**Netherlands**
♦ Pilotage is compulsory for the following: - Loaded oil tankers >1500 DWT; - Loaded chemical tankers carrying dangerous liquid chemicals covered by the IMO Chemical Code; - Gas carriers; - Vessels carrying radioactive cargoes; - Towing vessels of 150GRT+ navigating in dredged channels or marked navigation channels, into or past harbours or pilot stations (excluding harbour maneuvers); and - Tankers with uncleaned tanks not secured by inert gas. ♦ Ships sailing to and from Danish ports shall comply with the rules laid down in the ”Den danske havnelods” (The Danish Harbor Pilot book). ♦ Tankers have to take a pilot when entering certain ports, terminals etc.	♦ Compulsory district pilotage for: - Vessels with a length of 90 m or a breath of 13 m and more - Tankers carrying gas/chemicals/petroleum/petroleum products in bulk, or unloaded tankers if not cleaned, degassed or completely inerted ♦ Additional shore based pilotage: - if visibility is reduced - if pilot cutter is in a sheltered position - if light buoys are withdrawn due to ice - if requested by the master - if ordered by the VTS-authority ♦ Voluntary Deep sea pilotage available	♦ Radar surveillance at Den Helder, Terschelling and Schiermonnikoog (for port entry and departure and Wadden Sea traffic only). ♦ Harbour pilotage is compulsory for ships over 60m in length and for all vessels carrying oil, gas or chemicals. Voluntary deep-sea pilotage is available for ships required to use the North Hinder-German Bight mandatory route for tankers. Communications are normally carried out via VHF radio and ships are required to maintain a listening watch on VHF. Radar assistance is available on request in some ports. Pilotage is compulsory for Harlingen and other ports in the Wadden Sea.

IV Vessel traffic services (VTS)

IMO measures

None.

EC measures

None.

Other regional measures

None.

NATIONAL MEASURES

Denmark	Germany	Netherlands
No VTS arrangement in the area.	♦ VTS with permanent radar surveillance in following districts: - VTS German Bight - VTS Ems - VTS Jade - VTS Weser - VTS Elbe ♦ Services offered: - Information Service - Navigational Assistance Service - Traffic Organisation Service ♦ Mandatory for all vessels exceeding 50 m. of length (river Ems 40 m) and all vessels carrying certain dangerous goods	♦ VTS Den Helder: All vessels equipped with VHF are requested to participate in this system. Vessels within the area should report when entering and leaving the VTS area. Traffic surveillance is provided; ♦ VTS Terschelling: Reporting is mandatory for all vessels entering or leaving the VTS area; ♦ Wadden Sea Central Reporting Station: Is responsible for co-ordinating the relevant maritime authorities with regard to all incidents within the Wadden Sea area; ♦ VTS Schiermannikoog: Provides radar surveillance services for the Terschelling-German Bight TSS with range up to 48 miles; and ♦ VTS Delfzijl: VTS is mandatory for all vessels, which includes an information service.

V Environmental protection measures intended to reduce or combat pollution

IMO measures

Denmark, Germany and the Netherlands are Parties to MARPOL 73/78.

The designation of the North Sea and its coastal waters west of Great Britain and Ireland (North West European Waters) as a Special Area under MARPOL Annex I. This was implemented on a national level and entered into force in all three concerned countries.

The designation of the North Sea as a special area under MARPOL Annex V. Annex V entered into force in all three States concerned.

The designation of the North Sea as a Sox Emission Control Area under Annex VI of MARPOL 73/78 (not yet in force).

The 1990 London International Convention on Pollution Preparedness, Response and Co-operation (OPRC) promotes international co-operation in the event of a major oil pollution threat between all North Sea countries. The OPRC-HNS Protocol (not yet in force) establishes a framework for international co-operation in the event of incidents involving hazardous and noxious substances.

EC measures

Council Directive 93/75/ECC of 13 September 1993 concerning minimum requirements for vessels bound for or leaving Community ports and carrying dangerous or polluting goods (known as the HAZMAT Directive) has been in force since 1995.

The EC Directive 2000/59/EEC on port reception facilities for ship-generated waste and cargo residues, which entered into force in 2000, should be implemented by the concerned States by the end of 2002. It is the aim of the Directive to reduce the discharges of ship-generated waste and cargo residue into the sea, especially discharges, from ships using ports in the Community, by improving the availability and use of port reception facilities for ship-generated waste and cargo residues.

The EC Directive 1999/32/EC relating to a reduction in the sulphur content of certain liquid fuels.

As a follow up to the Erika incident, two other packages of measures are in the legislative procedure. Package 'Erika I' is completed and contains the following elements:

- further development of Port State Control;

- strengthening of provisions for and the control of Classification Societies;

- initiative for early phasing out of single hull tankers, mentioned in paragraph 8 above and being implemented in the EU by a regulation.

The proposals concerning package 'Erika II', passed on to the Council on 8 December 2000, consist of the following elements:

- setting up a common monitoring and information system for maritime traffic, which will in due course replace EC-directive 93/75/EEC;

- initiative for an additional compensation fund for damage by oil pollution;

- establishment of the European Maritime Safety Agency (EMSA).

Other regional measures

Bonn Agreement: basic agreement for co-operation in dealing with Pollution of the North Sea by Oil and other Harmful Substances. Close co-operation between B, DK, F, D, NL, N, S and UK. Zones of responsibility are established under the Bonn Agreement, for co-operation in terms of aerial surveillance and dealing with pollution of the North Sea by oil and other harmful substances.

Joint Maritime Contingency Plans on Combating Oil and Other Harmful Substances agreed between D and DK resp. NL (DENGER- resp. NETHGER-Plans), concerning bilateral co-operation especially in defined exterior and quick Response Zones.

Bilateral Administrative Agreements between D and DK resp. NL on co-operation in the field of aerial surveillance (coordination of flight times and corridors, joint flights, mutual assistance by aircraft of the other party).

Bilateral arrangements also apply between the Wadden Sea states in terms of Joint Maritime Contingency Plans.

D-NL-Memorandum of Understanding on Mutual Support in the Field of North Sea Emergency Towing Capacity (March 2000): mutual assistance by emergency towing vessels in an area between the outer limitation of the VTS-schemes and the coastline, incl. approaches to the seaports.

National measures

There are lots of different national measures regarding preventing and combating marine pollution.

Annex 15

Act of 25 May 1998, relating to the adaptation of the Dutch legislation on the conservation of nature and landscape (Nature Conservation Act 1998)

Act of 25 May 1998, relating to the adaptation of the Dutch legislation on the conservation of nature and landscape (Nature Conservation Act 1998)

We Beatrix, by the grace of God, Queen of the Netherlands, Princess of Orange-Nassau, etc. etc. etc. Greetings to all who shall see or hear these presents! Be it known:
Whereas We have considered that the need exists to adapt the Dutch legislation on the conservation of nature and landscape and that a legal basis is needed for granting subsidies to promote and support the policy on nature and landscape and payments for voluntary adapting farm management in specifically designated areas to contribute to the management of nature and landscape.

We therefore, having heard the Council of State, and in consultation with the States General, have approved and decreed as We hereby approve and decree:

Chapter I Definitions

Section 1

For the purposes of this Act and provisions laid down pursuant to this act:
a. Our Minister: Our Minister of Agriculture, Nature and Food Quality;
b. structure plan: structure plan as referred to in Section 9;
c. nature reserve: land or water, or a combination of land and water, that is of public interest for its natural beauty or particular scientific interest;
d. owner: the party registered as owner in the land register, on the understanding that if the land is subject to hereditary lease, or perpetual lease the owner shall be the hereditary leaseholder or the perpetual leaseholder, and that if the land is subject to hereditary lease for a specified period of time, a right of usufruct or a right of superficies, the hereditary leaseholder, the holder of the right of usufruct, or holder of the right of superficies registered in the land register shall also be understood to be the owner, provided that legal ownership is not held by a party other than the party registered in the land register;
e. user: the party which, by virtue of having a legal relationship other than that stated, makes use of the land;
f. area of scenic value, an expanse of land composed of undeveloped land, or cultivated and undeveloped land, the appearance of which, because of its structures, patterns, elements or otherwise, is of public interest for its historic and landscape value;
g. Directive (EEC) no. 79/409: Council Directive (EEC) no. 79/409 of 2 April 1979 on the conservation of wild birds (OJEC L 103);
h. Directive (EEG) no. 92/43: Council Directive (EEC) no. 92/43 of 21 May 1992 on the conservation of natural habitats and of wild flora and fauna (OJEC L 206);
i. priority species: a species indicated as such in Annex II to Directive (EEC) no. 92/43;
j. priority natural habitat type: a natural habitat type indicated as such in Annex I to Directive (EEC) no. 92/43;
k. initiative taker: the party that takes the initiative for a plan, project or other action as referred to in the first paragraph of Section 19d;
l. conservation objective: objective or objectives as referred to in the second paragraph of Section 10a;
m. Natura 2000: European ecological network comprising special areas of conservation as referred to in Directive (EEC) no. 79/409 and Directive (EEC) no. 92/43;
n. existing use: an activity for which an annual permit may or may not be required that existed at the time the area was designated a protected nature reserve to implement Directive (EEC) no. 79/409 and Directive (EEC) no. 92/43, and has since been carried out uninterruptedly.

Section 2

1. Unless otherwise indicated, Provincial Executives shall mean the Provincial Executives of the province in which the areas as referred to in Section 10a, or nature reserves or areas of scenic value, or protected nature reserves or protected areas of scenic value are situated entirely or for the main part.

2. Provincial Executives shall not designate areas of scenic value partially situated in another province unless agreed with the Provincial Executives from the other provinces.

3. Provincial Executives shall not decide on applications for the permits referred to in Section 16, or on the issue of the declaration referred to in the first paragraph of Section 8.39b of the Environmental Management Act, nor shall they adopt a management plan as referred to in Section 17, unless agreed with the Provincial Executives of the other provinces in which the protected nature reserve is partially situated.

4. Provincial Executives shall not adopt the management plan referred to in Section 19a unless agreed with the Provincial Executives of the other provinces in which the area, designated under Section 10a, first paragraph, or areas for which designation is being considered under Section 12, third paragraph, is partially situated.

5. Provincial Executives shall not decide on applications for the permits referred to in Section 19d (1) unless agreed with the Provincial Executives of the other provinces in which the which the area, designated under Section 10a, first paragraph, or areas for which designation is being considered under Section 12, third paragraph, is partially situated, in so far as the permit relates to these parts.

Chapter II. Nature policy plan

Section 3

In this chapter Our Ministers shall mean: Our Minister together with Our Minister of Public Housing, Spatial Planning and the Environmental and Our Minister of Transport, Public Works and Water Management, in so far as matters are concerned that fall within their competence.

Section 4

Our Ministers shall adopt a nature policy plan at least once every eight years, which with a view to the sustainable conservation, restoration and development of natural and landscape values in the short, medium and long term, shall provide a basis for government decisions.

Section 5

1. The nature policy plan shall at least define the main planks of policy on:

a. general nature and landscape values;
b. protection of those areas and area categories indicated in the plan which are considered to have special nature and landscape values;
c. the plant and animal species indicated in the plan to which special attention shall be devoted;
d. information and research regarding nature and landscape;
e. international developments in nature policy.

2. The nature policy plan shall provide an indication of:

a. the manner and measures by which the main planks of policy shall be implemented over the next eight-year period;
b. a reasonable estimate of the financial and economic consequences of the policy to be followed.

Section 6

1. In the plan Our Ministers shall also indicate the extent to which the proposed policy on nature and landscape is in line with or shall lead to amendments in national environmental policy and water management policy, and the extent to which and the time frame within which they intend to review the national environmental plan, as referred to in Section 4.3 of the Environmental Management Act and the National Policy Document on Water Management, referred to in the first paragraph of Section 3 of the Water Management Act.

2. The current nature policy plan shall also be taken into account when adopting government policy in areas other than those set out in the first paragraph, in so far as they affect the sustainable conservation, restoration and development of nature and landscape values.

Section 7

1. When preparing the nature policy plan Our Ministers shall involve those administrative bodies, institutions and organisations which they consider to be most concerned with the matters to be addressed. Provincial Executives shall always be involved.

2. Preparations for the nature policy plan Section 3.4 of the General Administrative Law Act shall apply. Anyone may put forward their views.

Section 8

1. The plan has a duration of eight years after it is adopted, unless a new plan is adopted in that period.

2. After the first four years of the plan's duration have elapsed, Our Ministers may, with due observance of Section 7, amend the plan after an assessment of the experiences over this period.

3. Our Ministers shall present the plan and any amendments made to the plan to the States-General and the Provincial Executives.

4. Our Minister shall announce the adoption of the plan and any amendments made to it in the Official Gazette, and shall indicate how to obtain the contents of the plan or the amendments made to it.

Section 9

There shall be a structure plan that provides an insight into the spatial planning aspects of the government's nature and landscape policy. The structure plan shall be the plan referred to in Section 2a of the Spatial Planning Act.

Section 9a

1. The National Institute for Public Health and the Environment (hereinafter referred to by its Dutch abbreviation: RIVM) shall submit a scientific report to Our Minister once every four years, describing the state of nature, forest and landscape, and the most likely and possible other future developments for a period indicated by Our Minister.

2. RIVM shall submit a scientific report to Our Minister on an annual basis, which partly in the light of developments described in earlier reports, shall describe the state of policy implementation, the progress made and any new developments. Should an unforeseen circumstance arise that may have important long-term consequences for the development of nature, forest and landscape, RIVM will describe the possible consequences in a separate report, at the request of Our Minister.

Section 9b

1. Our Minister shall, together with Our Ministers of Public Housing, Spatial Planning and the Environment, of Transport, Public Works and Water Management, and of Economic Affairs – in so far as they are concerned – appoint the government bodies that RIVM shall engage in the preparation of the reports referred to in Section 9a.

2. Our Minister may, together with Our Ministers of Public Housing, Spatial Planning and the Environment, of Transport, Public Works and Water Management, and of Economic Affairs – in so far as they are concerned – establish rules governing the manner in which the said appointed government bodies are engaged in the preparation of the reports.

3. RIVM and the said appointed government bodies shall provide each other when asked with all the information and details at their disposal which may be necessary for the preparation of the reports referred to in the first and second paragraphs of Section 9a. .

Section 9c

1. Our Minister may give instructions on the expected developments that the descriptions in the report as set out in the first paragraph of Section 9a, are to be based on as well as the other matters that must be described therein.

2. Subject to the second paragraph of Section 9a and the first paragraph of this Section, Our Ministers shall not instruct RIVM and the said appointed government bodies on the content of the reports.

Section 9d

1. Our Minister shall submit the report referred to in the first paragraph of Section 9a to the States-General.

2. Our Minister shall also submit the report referred to in the second paragraph of Section 9a to the States-General at the same time as the budget.

3. The RIVM shall ensure that the reports are made available to the public.

Chapter III. Protected areas

Title 1. The designation of areas

Section 10

1. On the basis of the structure plan Our Minister may, by decree, designate a nature area as protected nature reserve. This designation shall be accompanied by a map indicating the protected nature reserve and an explanation.
2. If the nature reserve or part of it, is managed by one of Our other Ministers, Our Minister shall not take the decision referred to in the first paragraph, unless it is agreed with that other Minister.
3. If in cases other than the one referred to in the second paragraph one of Our other Ministers is legally authorised to take decisions regarding the protected nature reserve, consultation shall take place with that other Minster before the decision referred to in the first paragraph is taken.

Section 10a

1. Our Minister shall, by decree, designate areas to implement directive 79/409/EEC and directive 92/43/EEC.
2. The decision referred to in the first paragraph shall incorporate the conservation objective for this area. This conservation objective shall at least include:
a. the objectives for the conservation of the area's habitats insofar as required under directive 79/409/EEC, or

b. the objectives for the conservation of the natural habitats or populations of the plant and animal species living in the wild insofar as required under directive 92/43/EEC.

3. The conservation objective referred to in the second paragraph may also include objectives covering the conservation, restoration and development of areas of natural beauty or particular scientific interest other than those required under the directives referred to in the second paragraph.
4. The decision referred to in the first paragraph shall be accompanied by a map with a precise delineation of the designated area and an explanation.
5. Section 10, second and third paragraph, shall apply *mutatis mutandis*.

Section 11

1. Preparations for the decision referred to in Sections 10 (1) and 10a (1) shall be subject to Section 3.4 of the General Administrative Law Act, on the understanding that it is applied by the Provincial Executives.
2. Anyone may put forward their views.
3. Within four months of the expiry of the term laid down in section 3.16 (1) of the General Administrative Law Act, the Provincial Executives shall send to Our Minister the views put forward by the public accompanied by their own considerations. At the request of the Provincial Executives Our Minister may extend the term referred to in the first sentence by eight weeks.

Section 12

1. In case of urgent necessity Our Minister may, by decree, provisionally designate an area for which the decision referred to under Section 11 is being prepared, as protected nature reserve before the procedure referred to in Sections 11 and 13 has been completed.
2. The decision for provisional designation shall become redundant as soon as the definitive decision is taken with due observance of Sections 11 and 13, but always a year after the draft decision has been made available for public inspection in accordance with Section 11.
3. Paragraphs 1 and 2 shall apply *mutatis mutandis* to the areas referred to in Section 10a (1) on the understanding that the phrase in the second paragraph starting with ‘but always … and ending with Section 11’ does not apply.

Section 13

Within a year from the date the draft decision for the designation of an area as nature reserve has been made available for public inspection, Our Minister shall decide on the designation as nature reserve but not before he has received the considerations referred to in Section 11(2) or the terms referred to in that Section have expired.

Section 14

1. The decision to provisionally designate a nature area as nature reserve referred to in Section 12 shall be made known to the area’s owners and mortgagee.
2. Our Minister shall publish the decision to provisionally designate a nature area as nature reserve referred to in Section 12 in the Official Gazette.
3. If Our Minister does not take the decision to designate a nature area as nature reserve he shall make this known and shall notify this in accordance with paragraphs 1 and 2 and Sections 3:42 and 3:43 of the General Administrative Law Act.
4. Paragraphs 1, 2 and 3 shall apply *mutatis mutandis* to the decisions referred to in Section 10a (1).

Section 15

1. Our Minister may, by decree, change or withdraw, fully or in part, the decision to designate an area as nature reserve. The decision shall be accompanied by an explanation and in the case of a partial change or withdrawal a map indicating the area concerned.
2. In such cases section 10, paragraphs 2 and 3, and Sections 11 through 14 shall apply
3. Paragraphs 1 and 2 shall apply *mutatis mutandis* to the decisions referred to in Section 10a (1).

Section 15a

1. Areas that are designated under Section 10a(1) or areas that are considered for designation pursuant to Section 12(3) may not be designated as nature reserve pursuant to Section 10(1).
2. The decree designating an area as protected nature reserve pursuant to Section 10 (1) shall become redundant from the date the area is part of or insofar as it is part of the designated area referred to in Section 10a(1).
3. If on the application of the second paragraph the decree designating an area as protected nature reserve has fully or partially become redundant, the conservation objective for the area designated pursuant to Section 10a(1) shall also apply to the objectives covering the conservation, restoration and development of areas of natural beauty or particular scientific interest as provided for in the redundant decision.

Title 2. Legal consequences

§ 1. Legal consequences for protected nature reserves

Section 16

1. In protected nature reserves it is prohibited, without a permit issued by the Provincial Executives or by Our Minister for the activities referred to in paragraph six, to carry out, have carried out or tolerate activities that may damage the area's natural beauty, scientific interest, or wildlife, or activities that may deface the area or violate the conditions or restrictions laid down in the permit.
2. Damaging activities always include activities that will damage the area's essential characteristics referred to in the decision to designate the area as protected nature reserve.
3. Insofar as the permit referred to in the first paragraph concerns carrying out, having carried out or tolerating activities that may have significant consequences for the area's natural beauty, scientific interest, or wildlife, it shall not be issued unless there is the certainty that those activities do not compromise the area's natural characteristics or unless an overriding public interest is at stake.
4. The prohibition referred to in the first paragraph shall also apply to such activities as referred to in that paragraph that may be carried out outside the protected nature reserve and are mentioned in the decision to designate the area as protected nature reserve referred to in Section 10, or in the decision for provisional designation referred to in Section 12. The activities allowed under the said permit may be subject to restrictions and exceptions regarding the time, the conditions, the objectives or the persons designated to carry them out.
5. This Section shall not apply to the activities laid down in the site management plan referred to in Section 17.
6. The activities referred to in the first paragraph for which a permit from Our Minister is required may be designated by order in council.
7. The order in council pursuant to paragraph 6 shall not enter into force until eight weeks after the date of issue of the Official Gazette in which it is published. The Senate and the House of Representatives of the States General shall be informed immediately of its publication.

Section 17

1. Provincial Executives may in agreement with the owner or user draw up a management plan for the whole or part of the protected nature reserve to ensure the conservation, restoration and development of its areas of natural beauty or particular scientific interest.
2. Management plans shall include a subsidy payment to be paid by the Provincial Executives to meet the costs and burdens ensuing from the implementation of the management plan that cannot reasonably expected to be borne, or borne fully, by the owner and user.
3. Provincial Executives shall bring the plan to the notice of Our Minister and the Municipal Executives of the municipalities where the protected nature reserve or the part of it covered by the management plan is situated.
4. The owner and user shall, each within the scope of their entitlement, ensure compliance with the management plan.

Section 17a [Defunct as of 20-09-2000]

Section 17b [Defunct as of 20-09-2000]

Section 17c [Defunct as of 20-09-2000]

Section 17d [Defunct as of 20-09-2000]

Section 18

1. The management plans referred to in Section 17 shall be drawn up for a maximum period of six years.
2. Management plans shall by operation of a law be extended by a period equal to that which previously expired under the management plan that was drawn up.
3. Management plans shall not be extended by operation of a law when the Provincial Executives, the owner or user, four weeks before the current management plan expires, has given written notification that extension of the management plan is not desired.
4. Provincial Executives may only give notification if:

a. owners or users have not complied with the requirements laid down in the management plan in the appropriate manner over the previous period;
b. unmodified extension of the management plan might result in management that in their judgement would not sufficiently ensure the conservation, restoration and development of areas of natural beauty or particular scientific interest of the protected nature reserve;
c. there is a another, serious reason not to decide to extend the management plan period.

Section 19

1. Provincial Executives may in agreement with the owners or users modify an adopted management plan.
2. Section 17, third paragraph, shall apply *mutatis mutandis.*

§ 2. Legal consequences for areas implementing European requirements

Section 19a

1. After consultation with the owners, users or other stakeholders, Provincial Executives shall adopt management plans for areas designated under Section 10a, first paragraph, or areas for which designation is being considered under Section 12, third paragraph, which, with due observance of the conservation objective, describes the conservation measures to be taken and the manner thereof.
2. Management plans referred to in the first paragraph shall be drawn up for a maximum period of six years. Management plans may always be extended for a period of equal length.
3. A management plan shall at least include:

a. a description of the envisaged results with a view to the conservation or restoration of natural habitats or populations of the plant and animal species living in the wild in a favourable conservation status in the designated area in conjunction with the area's existing uses;
b. a survey of the measures for the period covered by the plan with a view to the envisaged results referred to under a.

4. Preparations for management plans referred to in the first paragraph shall be subject to the procedure provided for by section 3.4 of the General Administrative Law Act.
5. Management plans shall be adopted only after consultation with municipal authorities and water boards in the area covered by the management plan.
6. Management plans referred to in the first paragraph shall be adopted for the first time within three years after the date the decision referred to in Section 10a, first paragraph, was taken.

Section 19b

1. By way of derogation from the provision laid down in Section 19a management plans referred to in that Section for areas designated under Section 10a, first paragraph, or areas for which designation is being considered under Section 12, third paragraph, that are entirely or in part managed by or for Our Minister or one of Our other Ministers shall, for the whole or the relevant part be adopted by Our Minister or by one of Our other Ministers in agreement with Our Minister and, where necessary after consultation with the owners, users and other stakeholders involved.

2. Management plans referred to in the first paragraph may be part of other plans aimed at the management of the areas referred to in the first paragraph whether or not these were adopted under a legal requirement .
3. Management plans shall be adopted only after consultation with provincial and municipal authorities and water boards in the area covered by the management plan.
4. Section 19a, paragraphs two, three, four and six shall apply *mutatis mutandis*

Section 19c
Defunct

Section 19d
1. In protected nature reserves it is prohibited, without a permit or in violation of the conditions or restrictions laid down in the permit issued by the Provincial Executives or by Our Minister for the activities referred to in paragraph three, to carry out or realise projects or other activities that in view of the area's conservation objective may have an adverse effect on the quality of the natural habitats and the habitats of species in areas designated under Section 10a, first paragraph, or areas for which designation is being considered under Section 12, third paragraph, or disturb the species for which the area was designated. Such projects or other activities always include projects or activities that will damage the area's essential characteristics.
2. The prohibition referred to in the first paragraph shall not apply to the realisation of projects or activities in accordance with the area's management plan referred to in Sections 19a or 19b.
3. The projects or other activities referred to in the first paragraph for which a permit from Our Minister is required may be designated by order in council.
4. The order in council pursuant to paragraph 3 shall not be put forward until four weeks after the proposal is presented to the Senate and the House of Representatives of the States General.

Section 19e

On issuing the permit referred to in Section 19d, first paragraph, Provincial Executives shall take into account
a. the consequences of a project or other activity the permit relates to in view of the conservation objective of areas designated under Section 10a, first paragraph, or areas for which designation is being considered under Section 12, third paragraph, and
b. the management plan adopted under Section 19a or Section 19b.

Section 19f

1. The consequences of applications for the permit referred to in Section 19d, first paragraph, for new projects or other activities decided by Provincial Executives, which are not directly related to or necessary for the management of areas designated under Section 10a, first paragraph, or areas for which designation is being considered under Section 12, third paragraph, but which in themselves or in combination with other projects or activities may have significant consequences for the areas in question shall be assessed appropriately with due observance of the area's conservation objective by the initiative taker prior to their submission to Provincial Executives.
2. The appropriate assessment concerning decisions on applications for the permit referred to in Section 19d, first paragraph, may be part of the EIA required for the said projects or activities.
3. The requirement for an appropriate assessment in preparations for the decision referred to in the first paragraph shall not apply when the person carrying out the said projects or activities does so to repeat or continue projects or activities for which appropriate assessments had already been made provided that new assessments are not likely to yield new insights into the significant consequences of the projects or activities.

Section 19g

1. The permit referred to in Section 19d, first paragraph, shall be issued only after the Provincial Executives have ascertained from the appropriate assessment referred to in section 19f, that the natural characteristics of the area involved will not be compromised.
2. By way of derogation from the first paragraph, Provincial Executives may, in the absence of alternative solutions, issue the permit referred to in Section 19d, first paragraph, for projects or activities in areas designated under Section 10a, first paragraph, or areas for which designation is being considered under Section 12, third paragraph, which do not support priority types of natural

habitat or priority species, to realise the said projects or carry out the said activities only if there are reasons of overriding public interest, including those of an economic or social nature.
3. By way of derogation from the first paragraph, Provincial Executives may, in the absence of alternative solutions, issue the permit referred to in Section 19d, first paragraph, for projects or activities in areas designated under Section 10a, first paragraph, or areas for which designation is being considered under Section 12, third paragraph, which do support priority types of natural habitat or priority species, to realise the said projects or carry out the said activities only:
a. On the basis of arguments related to public health, public safety, or because of patently favourable effects on the environment.
b. For other reasons of overriding public interest after advice from the European Commission.
4. Our Minister shall request the advice referred to in paragraph three (b).

Section 19h

1. If the permit referred to in Section 19d, first paragraph, is issued for reasons of overriding public interest for projects or activities of which it has not been established with any certainty that they do not compromise the natural characteristics of areas designated under Section 10a, first paragraph, or areas for which designation is being considered under Section 12, third paragraph, Provincial Executives shall always attach to the permit the requirement to take compensatory measures.
2. Provincial Executives shall always give the initiative taker the opportunity to make proposals for compensatory measures first, in good time.
3. Proposals for compensatory measures shall always include the manner in which these measures are to be taken and a time schedule.
4. Where compensatory measures are prescribed with a view to the objectives referred to in Section 10a(2) under b and c, the envisaged result of these measures must have been achieved at the moment when the significant consequences referred to in Section 19f, first paragraph, become apparent, unless it can be demonstrated that this concurrence is not necessary to safeguard the area's contribution to Natura 2000.
5. By order in council Our Minister may, in agreement with Our other Ministers who are also involved, set further requirements with regards to compensatory measures.

Section 19i

Where Our Minister is authorised to decide on the application of a permit referred to in Section 19d, first paragraph, Sections 19e, 19f, 19g and 19h shall apply *mutatis mutandis*.

Section 19j

1. Decisions for the adoption of plans that in view of the area's conservation objective may have an adverse effect on the quality of the natural habitats and the habitats of species in areas designated under Section 10a, first paragraph, or areas for which designation is being considered under Section 12, third paragraph, or disturb the species for which the area was designated requires approval of Our Minister. A plan prepared by one of Our other Ministers shall be adopted in agreement with Our Minister.
2. By way of derogation from the first paragraph decisions for the adoption of plans drawn up by municipal authorities and water boards shall be approved by Provincial Executives.
3. Sections 19e, 19f, 19g and 19h shall apply *mutatis mutandis* to the decisions for the adoption of plans referred to in the first paragraph, irrespective of the restrictions in the legal provision on which it is based.
4. By way of derogation from the first paragraph, the plans referred to in Section 19a shall not require approval from Our Minister.

Section 19k

1. Provincial Executives shall notify Our Minister of the projects and activities referred to in the first paragraph of Section 19f, and of the plans referred to in the second paragraph of Section 19j and send Our Minister a copy of the permits referred to in the first paragraph of Section 19d, and the decisions of approval referred to in the second paragraph of Section 19j, taken under Section 19g. They shall also notify Our Minister of the compensatory measures referred to in Section 19h.

2. Our Minister shall notify the Commission of the European Communities of the compensatory measures referred to in the first paragraph.

Section 19ka

1. If, for the realisation of a project or activities, in addition to the permit referred to in the first paragraph of Section 19d, other decisions need to be taken, the administrative body to which the initiative taker has submitted the relevant application shall see to it that he is informed of those other decisions which the administrative body may reasonably assume are necessary.
2. The initiative taker may request in writing one of the administrative bodies to coordinate the decision-making process.
3. The administrative bodies involved may also ex officio decide to coordinate the decision-making process. If this is the case, the initiative taker shall be informed.
4. If the request referred to in the second paragraph has been submitted or if coordination of the decision-making process has been decided on, the administrative bodies involved shall appoint a coordinating body from their midst. In the absence of such a coordinating body the administrative body itself shall be the deciding authority.
5. The coordinating administrative body shall work towards an effective and coherent decision-making process. The other administrative bodies involved shall cooperate with them to make the decision-making process a success.

§ 3. Other legal consequences

Section 19l

1. All shall take sufficient care for the conservation of areas designated under Section 10, first paragraph or Section 10a, first paragraph, or areas for which designation is being considered under Section 12.
2. The care, referred to in the first paragraph implies that any one who knows or may reasonable be expected to know that, in the light of the area's conservation objective, their actions or failure to act may have adverse consequences for the areas designated under Section 10a, first paragraph, or for the essential characteristics of areas designated under Section 10, first paragraph, shall refrain from such actions or, where this cannot reasonably be expected, take all possible measures to prevent the adverse consequences or at least limit or undo them.

Section 20

1. Provincial Executives may restrict access to areas or parts thereof designated under Section 10, first paragraph or Section 10a, first paragraph, or areas for which designation is being considered under Section 12 in so far as this is necessary for the protection of their nature values.
2. If the areas referred to in the previous paragraph are entirely or in part managed by or for Our Minister or one of Our other Ministers, the authorisation, referred to in the first paragraph, shall be given by Our Minister in agreement with Our other Minister.
3. It is prohibited to be in the areas or parts thereof designated under Section 10, first paragraph or Section 10a, first paragraph, or areas for which designation is being considered under Section 12, in violation of the restrictions referred to in the first and second paragraph.
4. The prohibition laid down in the third paragraph shall not apply to the owner or user of the areas or parts thereof designated under Section 10, first paragraph or Section 10a, first paragraph, or areas for which designation is being considered under Section 12, if their user right extends to the said areas.

Section 21

1. If, as a result of a lack of measures, the natural beauty or scientific interest of a protected nature reserve are, or threaten to be, seriously compromised, Provincial Executives may decide to put the necessary measures in place to restore or maintain the area's natural beauty or scientific interest.

2. The owner and user shall tolerate such measures.

3. Provincial Executives shall not put the necessary measures in place until they have notified the

owner and user of their intentions, and, unless immediate action is required, not until four weeks of their written notification have elapsed.

4. The first, second and third paragraph shall apply *mutatis mutandis* to the areas designated under Section 10a, first paragraph, or areas for which designation is being considered under Section 12, third paragraph, on the understanding that the necessary measures are taken if, in the light of the conservation objective, the quality of the natural habitats and the habitats of species in the designated area is compromised or if disturbing factors should arise that could have a significant effect on the species for which the area was designated. If the area is managed by or for Our Minister or one of Our other Ministers, the necessary measures shall be put in place by Our Minister or one of Our other Ministers in agreement with Our Minister.

Section 22

1. After consultation with the owners and users Provincial Executives may put up notices in the area to announce its designation as protected nature reserve and the legal consequences this entails.

2. The owners and users shall tolerate such notices being put up in the area.

3. The first and second paragraph shall apply *mutatis mutandis* to the areas designated under Section 10a, first paragraph, or areas for which designation is being considered under Section 12, third paragraph.

Chapter IV. Protected areas of scenic value

Section 23

1. Provincial Executives may, by decree, designate areas of scenic value as protected areas of scenic value.
2. If the area concerned has already been designated as protected nature reserve, Provincial Executives shall take this into account when drawing up the decree.
3. Provincial Executives may, by decree, change or withdraw, fully or in part, the decision to designate areas of scenic value as protected areas of scenic value.
4. The second paragraph and Sections 24 to 26 shall apply *mutatis mutandis* to the decree, referred to in the third paragraph.

Section 24

1. The decree referred to in Section 23, shall at least include:
a. a description of the characteristics of the areas of scenic value, in so far as these characteristics are visible;
b. an indication of the activities that might compromise the characteristics referred to in paragraph a.
2. The decree shall be accompanied by a map with a precise delineation of the designated area and an explanation.

Section 25

1. Before deciding to designate an area as a protected area of scenic value, Provincial Executives shall send the draft decree to the municipal council of the municipalities in which the protected area of scenic value is situated and to the provincial planning authorities. The municipal council shall make recommendations within six months of receiving the draft decree. The provincial planning authorities shall make recommendations within six months of receiving the draft decree.
2. Within a year of sending the draft decree referred to in the first paragraph, Provincial Executives shall decide whether to assign protected status to the area but not without first receiving the recommendations or before the period referred to in the first paragraph has elapsed.
3. Provincial Executives shall publish their decision to designate an area as a protected area of scenic value in the Official Gazette and in one or more local newspapers in the area concerned.

4. Provincial Executives shall send a copy of their decision to designate an area as a protected area of scenic value to Our Minister and the municipal council of the municipalities in which the protected area of scenic value is situated.

Section 26

1. The municipal council responsible for the area in which the protected area of scenic value is situated shall adopt a land use plan as referred to in the Spatial Planning Act, to protect the area of scenic value. Provincial Executives may lay down a time limit for this in the decree.
2. In the decree designating an area as protected area of scenic value Provincial Executives shall determine whether, and if so, to what extent, existing spatial plans can be considered to be protected area plans in the sense of the first paragraph.

Chapter V. International obligations

Section 27

1. Our Minister shall designate areas for the implementation of treaties or other international obligations on nature and landscape conservation, with the exception of EEC Directive no. 70/409 and EEC Directive no 92/3, where this is required under the said treaties or other international obligations.
2. The decision referred to in the first paragraph shall be accompanied by a map with a precise delineation of the designated area and an explanation. The explanation must include details of how conservation of the area will be achieved, in line with the provisions laid down in the said treaties or obligations.
3. The decision referred to in the first paragraph shall be published in the Official Gazette and in one or more local newspapers in the area concerned.

Section 28

Before deciding to designate the areas referred to in Section 27 (1), the Minister shall consult the provincial and municipal councils of the areas concerned.

Section 29

1. By order in council further rules may be set with regards to the implementation of treaties or other international obligations on nature and landscape conservation laid down in this Act.
2. The rules referred to in the first paragraph may include criteria for assessing areas to be designated under Section 27.
3. The rules referred to in the first paragraph may also include the option to provisionally designate an area for which the procedure referred to under Section 28 has not yet been completed.

Section 29a

1. Without prejudice to what is established elsewhere in this Act or by order in council, rules on matters to which this Act applies may be set by Ministerial order, on condition that these rules only apply to the implementation of a treaty which is binding for the Netherlands or to other decisions of organisations governed by international law.
2. Under the Ministerial order referred to in the first paragraph, matters established under this Act, or by order in council may be declared null and void, if this is required for the correct and timely implementation of the treaty or decision referred to in the first paragraph.
3. If matters established under this Act or by order in council under this Act are declared null and void, Our Minister shall ensure replacement of the Ministerial order. If this replacement requires an Act, a legislative proposal shall be submitted to the States General within two years of the implementation of the Ministerial order. If replacement requires an order in council, recommendations shall be made to Us within a year of the order coming into effect.

Chapter VI. Compensation

Section 30

For the purposes of this Chapter, the competent authority shall be the body that has taken or is deemed to have taken the decision referred to in Section 31.

Section 31

1. If it can be demonstrated that a stakeholder as a result of a decision made under Chapter III of this Act, suffers or will suffer damage that should not or not fully be at the expense of the stakeholder and for which compensation through purchase, expropriation or otherwise is not sufficient, or not sufficient enough, the body that has taken or is deemed to have taken the decision, may at the stakeholder's request grant him or her a reasonable compensation.
2. For such compensation requests the competent authority may ask the advice of the damage assessment committee, referred to in Section 32.

Section 32

1. A damage assessment committee shall be set up by the competent authority.
2. The damage assessment committee shall be made up of one or more members.
3. Members of the damage assessment committee set up by Our Minister may not be employed as official at the Ministry or at a service, business or agency working under the responsibility of Our Minister.
4. For the purposes of this chapter, the official referred to in the third paragraph shall mean any person equal to those working under a civil law contract of employment.
5. Members of the damage assessment committee may not hold the following positions:
   a. Queen's commissioner
   b. a member of Provincial Executives
   c. an official appointed by or on behalf of provincial authorities or answerable to them.
6. For the purposes of this chapter, the official referred to in paragraph 5 (c) shall mean any person equal to those working under a civil law contract of employment in the service of the provincial authorities.

Section 33

1. If the competent authority decides to ask the advice of the damage assessment committee, it shall send a request to that effect within two weeks of receiving the application for damages. The request for advice shall be accompanied by all relevant documents and the applicant shall be informed forthwith.
2. The competent authority shall cooperate with the damage assessment committee as required.

Section 34

1. The damage assessment committee shall give the applicant or their representative the opportunity to explain their application for damages at a public meeting.
2. A damage assessment committee set up by Our Minister may summon officials employed by the Ministry or a service, business or agency working under the responsibility of Our Minister to appear at a public meeting to be heard.
3. A damage assessment committee set up by Provincial Executives may summon one or more members of the Provincial Executive, including its chair and officials appointed by or on behalf of provincial authorities or answerable to them to appear at a public meeting to be heard.
4. If the damage assessment committee wishes to visit the scene of the damage it shall give the applicant and the competent authority prior notification of the time of the visit.

Section 35

The damage assessment committee shall submit a reasoned advice to the competent authority within thirteen weeks of receiving the request for advice. A copy of the advice shall be sent to the applicant at the same time.

Section 36

1. The competent authority shall give the applicant or their representative the opportunity to present his or her view of the advice, in person or in writing, in the presence of the damage assessment committee.
2. If the damage assessment committee was set up by Provincial Executives the view, referred to in the first paragraph, when given in person, shall be presented before one or more members of the Provincial Executive, including its chair.
3. At the competent authority's request the damage assessment committee shall further explain the advice and when asked, give its opinion of the applicant's view of the matter.

Section 37

The costs of the damage assessment committee shall not be passed on to the applicant.

Section 38

The competent authority shall within nine weeks of receiving the advice from the damage assessment committee give their ruling or, if such advice was not asked, within thirteen weeks from receiving the request for compensation.

Chapter VII. Appeal and registration

Section 39

1. Stakeholders may appeal against the decisions taken under this Act by writing to the administrative law department of the Council of State.
2. Decisions referred to in Section 15, shall not come into effect until the term of appeal has expired or in the event of an appeal, while the appeal is decided.

Section 40

Our Minister shall register the decrees pursuant to Section 10 (1), Section 10a (1) or Section 15 forthwith in the public registers referred to in Section 16 of Book III of the Civil Code, if within the terms that apply no objection or appeal was lodged or in the event of an appeal, while the appeal is decided. Section 24(1) of Book III of the Civil Code does not apply.

Chapter VIII. Procedure for the issue of permits

Section 41

1. In applying for the permits referred to in Sections 16 and 19d applicants shall motivate their interests.
2. The receipt of applications shall be confirmed in writing.

Section 42

1. Applications for permits shall be decided on within thirteen weeks from receiving them.
2. The body that decides on the issue of permits may extend this period once, by thirteen weeks. The applicant and the Municipal Executive, referred to in Section 44, shall be informed of the extension of this period.
3. The body that decides on the permits referred to in Sections 16 and 19d may decide to issue, change or withdraw a permit and shall make their decision known in one or more local newspapers in the area concerned or in an other appropriate manner. Giving the factual contents will suffice.

Section 43

1. A permit may be subject to conditions.
A permit may be subject to restrictions. By order in council further rules may be set with regards to the said conditions and restrictions.
2. A permit may be withdrawn or changed if:
a. its holder acts in violation of the conditions or restrictions the permit is subject to;
b. the information on the basis of which the permit was issued proves to be incorrect or incomplete to the extent that had the information been correct or complete the decision would have been different;
c. the permit was issued in contravention of the legal provisions in place; or
d. the circumstances since the permit was issued have changed to such an extent that, had those circumstances existed at the time of issue, the permit would not have been issued without conditions or restrictions or only subject to other conditions or restrictions.

Section 44

1. If Our Minister is authorised to issue permits he shall send a copy of the application and the confirmation of receipt to the Provincial and Municipal Executives of the area covered by the permit.
2. If Provincial Executives are authorised to issue permits they shall send copies of the documents, referred to in the first paragraph, to the Municipal Executives of the area covered by the permit and to Our Minister.
3. The Provincial and Municipal Executives or the Municipal Executives may within eight weeks of the date stated on the confirmation of receipt present their view to the body that decides on the permits.

Section 45

1. Our Minister may, if it is in the public interest, advise Provincial Executives in their decision on the permits referred to in Sections 16 and 19d, permits already issued under Section 16 and 19d and the management plans referred to in Sections 17 and 19a.
2. Our Minister shall consult with the Provincial Executives on his intention to advise them.
3. In their decision Provincial Executives shall give notice of the advice received from Our Minister
4. If, within the term given, Provincial Executives do not, or not properly, follow up the advice referred to in the first paragraph, Our Minister shall decide on the permit concerned.

Section 45a

1. Our Minister may, if it is in the public interest, advise the administrative body on the decisions referred to in the first paragraph of Section 19j.
2. The power referred to in the first paragraph shall not apply to administrative bodies belonging to the State.
3. Our Minister shall consult with the administrative bodies on his intention to advise them.
4. The administrative bodies shall, within six months, bring the decision referred to in the first paragraph in line with the advice of Our Minister.

Section 46 [Defunct as of 01-10-2005]

Chapter IX [Defunct as of 17-02-1999]

Section 47 [Defunct as of 17-02-1999]

Section 48 [Defunct as of 17-02-1999]

Chapter X. Enforcement

Section 49

1. The provisions under or pursuant to this Act shall be enforced by:
a. The officials Our Minister has appointed for this purpose by decree;
b. The officials Our Minister of Justice has charged under Section 17 of the Economic Offences Act with the investigation of punishable offences under or pursuant to this Act, and
c. The officials Provincial Executives have, by order, appointed for this purpose.
2. The decree referred to in the first paragraph under a, shall be published in the Official Gazette.

Section 50 [Defunct as of 01-10-2005]

Section 51 [Defunct as of 01-10-2005]

Section 52 [Defunct as of 01-10-2005]

Section 53 [Defunct as of 01-10-2005]

Section 54 [Defunct as of 01-10-2005]

Section 55 [Defunct as of 01-10-2005]

Section 56 [Defunct as of 01-10-2005]

Section 57

1. Our Minister shall be authorised to apply administrative enforcement with respect to the provisions under or pursuant to this Act concerning the projects and other activities for which he is authorised to issue a permit under Sections 16 and 19d.

2. At the request of Our Minister Provincial Executives shall issue a decree to allow the application of administrative enforcement if the provisions under or pursuant to this Act are not observed. Our minister may also determine a term within which his request must be met.

3. Provincial Executives shall send a copy of the decree referred to in the second paragraph to Our Minister.

Chapter XI. Final and transitional provisions

Section 58

1. In the event of the intended acquisition of land under Title VII of the Expropriation Act for nature conservation purposes Our Minister may prohibit the activities that compromise the natural beauty or scientific interest of the land intended for acquisition.

2. The prohibition no longer applies if the ownership of the land is conveyed to the expropriated party or if the intended acquisition has not been effected within two years unless there is a court case pending as referred to in Chapter III of Title I of the Expropriation Act. The term may be extended by one year at the most by a royal decree published in the Official Gazette.

3. Our Minister shall at all times be authorised to withdraw the prohibition in full or in part or to grant an exemption for it.

4. Our Minister shall publish the prohibition in the Official Gazette.

Section 59

Our Minister, and Provincial Executives may appoint officials to have access to all protected nature reserves as required for the performance of their duties.

Section 60

1. Decisions taken under Sections 7, 11, 12, 14, 18, 21, first paragraph, 28, 29, first paragraph, 30 and 31 of the Nature Conservation Act shall be equal to the decisions taken under Sections 10, 15, 16, 17, 31, 10, 49, first paragraph, 59 and 58 of this Act.

2. Decisions taken under Section 16 (2) under of c, the Nature Conservation Act, shall be equal to the decisions taken under Section 16 of this Act.

Section 60a

1. Decisions taken under Section 12 of the Nature Conservation Act for the projects and activities referred to in the first paragraph of Section 19d, shall apply to areas designated under Section 10a, first paragraph, or areas for which designation is being considered under Section 12, third paragraph as decisions taken under Section 19d.

2 This Act shall not apply to decisions on applications for permits or exemptions and other applications for authorisation governed by Article 6 of Directive (EEG) no. 92/43 received before this Act entered into force until the term of appeal has expired or in the event of an appeal, while the appeal is decided.

3. Management plans adopted under Section 14 of the Nature Conservation Act shall remain valid for the period for which they were adopted.

Section 61

Areas designated by Our Minister for the implementation of treaties or other international obligations on nature and landscape conservation before this Act entered into force shall count as areas designated under Section 27 of this Act.

Section 62

1. Decisions taken under the first paragraph of Section 8 of the Nature Conservation Act before this Act enters into force, shall remain subject to the procedures under Section 9 of the said Act.

2. Decisions taken under the second paragraph of Section 8 of the Nature Conservation Act before this Act enters into force, shall count as decisions taken under Section 12(1) of this Act on the understanding that to such decisions the procedures under Section 9 of the Nature Conservation Act apply.

3. The decisions referred to in Section 10, taken with due observance of the first paragraph, shall mention the activities referred to in Section 16(4) of this Act.

Section 63

1. Decisions on the applications for the permits or exemptions referred to in Section 12 or 16(2) under c of the Nature Conservation Act received before this Act entered into force, shall remain subject to the said Act until the term of appeal has expired or in the event of an appeal, while the appeal is decided.
2. The first paragraph shall apply *mutatis mutandis* to applications **made** before this Act entered into force for permits to carry out the activities referred to in Section 21(1) of the Nature Conservation Act in a protected nature reserve.

Section 64

The opportunity to file an objection or an appeal against decisions made known before this Act entered into force or the treatment of an objection or appeal made before this Act came into force shall remain subject to the Nature Conservation Act.

Section 65

By way of derogation from the provision under Section 16(4), the protected and state-owned nature reserves referred to in Sections 7(1) and 21(1) of the Nature Conservation Act designated as such under the Nature Conservation Act before this Act came into force, shall be subject to the prohibition under Section 16(1) of this Act with respect to the damaging activities carried out outside the protected nature reserve without them being mentioned in the decision to designate the area as protected nature reserve.

Section 66

The owner and user of a protected nature reserve shall tolerate the notices put up under Section 15 of the Nature Conservation Act after the Act has been repealed..

Section 67

Decisions on the application of administrative enforcement taken before the date this Act came into force and the resulting execution of the activities referred to in Section 29 first and second paragraph of the Nature Conservation Act, shall remain subject to the said Act.

Section 68

[Contains amendments to the Economic Offences Act.]

Section 69

[Contains amendments to the Water Management Act]

Section 70

[Contains amendments to the Environmental Management Act]

Section 71

1. [Contains amendments to the Nature Conservation Act.]

2. The Nature Conservation Act shall be repealed.

Section 72

[Amends this Act.]

Section 73

[Contains amendments to the General Administrative Law Act.]

Section 73a

1. The *Wet deelneming Grevelingen* shall be repealed.

2. Natuur- en Recreatieschap De Grevelingen shall receive 9.75 million euros in compensation for the withdrawal of government services provided the money is spent on nature, landscape and recreation in De Grevelingen.

3. Natuur- en Recreatieschap De Grevelingen or its legal successor shall be accountable to Our Minister of Agriculture, Nature and Food Quality for the way the money is spent and shall submit an annual statement to that effect accompanied by an auditor's report. The first sentence shall apply until 1 January 2030 or, if earlier, up to 1 January of the year following the year Natuur- en Recreatieschap De Grevelingen or its legal successor ceases to exist.

4. **If the condition laid down in the second paragraph or the requirement laid down in the third paragraph, first sentence, is not met,** Our Minister of Agriculture, Nature and Food Quality may claim back the amount of compensation fully or in part.

Section 74

This Act shall enter into force with effect from the date determined by royal decree which may be different per Section or part of a Section.

Section 75

This act shall be cited as: the Nature Conservation Act and shall give the year of the Official Gazette in which it is published

Signature

Direct and ordain that these presents shall be placed in the Official Gazette and that all the ministries, authorities, bodies and officials who may be concerned, shall strictly enforce its execution.

Given in the Hague, 25 May 1998

Beatrix

The Minister of Agriculture, Nature Management and Fisheries

J.J van Aartsen

Published on 14 July 1998

The Minister of Justice,
W. Sorgdrager

Annex 16

Part 4 of the "Third Policy Document on the Wadden Sea" - a Key National Planning Decision (PKB), 2007

Developing the Wadden Sea for nature and man

Part 4 of the key national spatial planning decision (PKB) on the Wadden Sea (text approved by Parliament)

Developing the Wadden Sea for nature and man

Part 4 of the 'Third Policy Document on the Wadden Sea' – a key national spatial planning decision (PKB) (text approved by Parliament)

January 2007

The PKB was drawn up by the Ministry of Housing, Spatial Planning & the Environment (VROM) in cooperation with the Ministries of Agriculture, Nature & Food Quality (LNV), Transport, Public Works & Water Management (VenW) and Economic Affairs (EZ).

Table of Contents

Part 4 of the 'Third Policy Document on the Wadden Sea' – a key national spatial planning decision (text approved by Parliament)

1. The nature and context of the Policy Document

1.1 The nature and scope of the PKB

This key national spatial planning decision (PKB) contains the main elements of government policy for the Wadden Sea. The PKB is area-specific in character and incorporates the spatial and spatially relevant elements of government policy for the Wadden Sea. The government will be guided by this PKB when engaging in international cooperation initiatives relating to spatial planning, making decisions on spatial-planning projects and preparing structure schemes and sectoral policy documents of relevance to the Wadden Sea. The PKB also lays the foundations for the spatial planning policy of provinces and municipalities.

Some statements made in the PKB are directly binding on other authorities. These are the concrete policy decisions within the meaning of Section 2a, subsection 1 of the Dutch Town and Country Planning Act (WRO). Other authorities must take these decisions into consideration when drawing up their spatial plans. Those sections of the PKB with the status of concrete policy decisions are printed in ***bold, italic, blue and underlined***. The other statements in this PKB are of an indicative nature.
Provinces and municipalities will have to take these statements into account when drawing up regional, structure and land-use plans. A number of statements are of such importance to the implementation of government policy that they have acquired the status of ‘decisions of vital importance’. This means that the government can only deviate from these statements by revising the PKB. These decisions of vital importance within the meaning of Article 3, para. 2 of the Decree on Spatial Planning are printed in **bold and blue**.

1.2 Plan horizon and planning period

The year 2030 is used in this PKB as the plan horizon for the Wadden Sea spatial planning vision and development perspective. The Wadden Sea Policy as outlined in this PKB will remain effective for a period of 10 years from the entry into force of this PKB. This period is designated as the planning period. The PKB can be modified in the meantime (e.g. if the results of the studies announced in the PKB warrant such an adjustment).

1.3 Geographical boundaries

PKB area
The “PKB area” referred to in this Key National Spatial Planning Decision is understood to be the area shown in PKB map A.

The boundaries of the PKB area extend from the coastal waters off Den Helder to the national border with Germany in the Dollard, including the area in the Ems estuary that is disputed between the Netherlands and Germany. The northern boundary of the PKB area is formed by the seaward toe of the flood defences, breakwaters and the harbour entrances and ferry causeways on the Wadden Sea side of the islands and, in the absence of these structures, includes the salt marshes and mudflats of the Wadden Sea coast of the islands as well as part of the inlets between the islands. The southern boundary of the PKB area is formed by the seaward toe of the flood defences, breakwaters and the harbour entrances and ferry causeways of the mainland of North Holland, Friesland (Fryslân) and Groningen and by the seaward toe of the IJsselmeer Dam (*Afsluitdijk*).
A more detailed description of the PKB boundary along the North Sea Coastal Zone and the Wadden Islands, together with the corresponding coordinates, is included in Appendix 1 to this PKB. References to the Wadden Sea in this PKB should be understood to mean the PKB area.

Wadden Sea Region
For the purposes of this PKB, the “Wadden Sea Region” refers to the Wadden Sea, the Wadden Islands, the inlets between the islands, the North Sea Coastal Zone up to 3 nautical miles offshore, and also the territory of the mainland municipalities that border the Wadden Sea. The Wadden Sea Region is shown in explanatory map 1.

The policy formulated in this PKB also relates to developments outside the PKB area in so far as these are of direct relevance to the PKB area itself. This so-called “external effect” is discussed in more detail in section 5.2.

1.4 International framework
The international framework for the Wadden Sea Policy is formed by international agreements and European Directives. Besides underlining the internationally recognised assets and uniqueness of the Wadden Sea, these also impose demands on national policy for the Wadden Sea. The Netherlands contributes to this international framework through its active involvement in international consultations.

The following are the most important international agreements and European Directives:

Schiermonnikoog Declaration
The Netherlands, Germany and Denmark have been collaborating to protect the Wadden Sea since 1978. The trilateral cooperation and conservation area is shown in explanatory map 7. With this agreement, the three countries are discharging their collective responsibility for the protection and sustainable development of the international Wadden Sea as a nature reserve of great international significance, as set down in the Schiermonnikoog Declaration (2005).

Bern Convention
The Bern Convention concerning ‘the conservation of wild flora and fauna and their natural habitats in Europe’ was signed in 1979 and came into force in 1982.

Bonn Convention
The Bonn ‘Convention on the Conservation of Migratory Species of Wild Animals’ was signed in 1979 and entered into force in 1983.

Ramsar Convention
Under the Ramsar Convention (1971), the Wadden Sea was designated as a wetland in 1984, with the emphasis being placed on conservation of its ecological assets. The boundaries of the wetland are based on ecological criteria. The Ramsar wetlands in the Northern Netherlands are shown in explanatory map 8.

The Birds and Habitats Directives
The European Union adopted the Birds Directive and the Habitats Directive in 1979 and 1992, respectively. The aim of these Directives is to maintain biological diversity in Europe. The Birds Directive aims to protect all wild bird species, while the Habitats Directive relates to the preservation of natural habitats and the wild flora and fauna in the European territory of the Member States. The Wadden Sea has been designated as a “special protection area” (SPA) under the Birds Directive since 1991 and as a “special area of conservation” (SAC) under the Habitats Directive since 2003. The protection of the areas designated under the Birds and Habitats Directives was enshrined in national legislation by the 1998 Nature Conservancy Act. The areas designated under the Birds and Habitats Directives are shown in explanatory maps 2 and 3, respectively.

European Water Framework Directive
The European Water Framework Directive, which came into force in 2000, requires all of Europe’s water bodies (surface, estuarine and groundwater) to achieve "good status" by 2015. For surface waters, this means both good ecological status and good chemical status. This applies to fresh surface water, transitional waters and coastal waters. For territorial waters as whole, Member States must endeavour achieve good chemical status. A fundamental premise of the Water Framework Directive is the adoption of a river basin district structure, whereby coastal waters are assigned to the nearest or most appropriate river basin district. The Wadden Sea falls under the basin districts of the rivers Rhine and Ems. See explanatory map 9.

Particularly Sensitive Sea Area
In 2002 the International Maritime Organization designated the Wadden Sea (and parts of the adjacent North Sea) as a Particularly Sensitive Sea Area (PSSA) – see explanatory map 10. Designation of the Wadden Sea as a PSSA is regarded as a recognition of the extensive package of existing protective measures for the Wadden Sea and does not result in additional restrictions for shipping or the use of harbours. The PSSA status is mainly intended to raise awareness of safe shipping (at national and international level).

Integrated Coastal Zone Management
Based on a Recommendation of the European Parliament and Council concerning “Integrated Management of Coastal Zones", the Netherlands presented a report about implementation in the Netherlands to the European Commission in February 2006. The Wadden Sea was included in this report as an example of international cooperation with regard to integrated management of coastal zones.

Ems-Dollard Convention
The environmental protocol (1996) to the Ems-Dollard Convention (1960) forms the basis for the coordination of policy and management for the area of the Ems-Dollard estuary which has been under dispute with Germany. The PKB on the Wadden Sea forms the Dutch point of reference in connection with the policy that is to be adopted with Germany in relation to the management of this area. Within the Ems-Dollard cooperation area, the Netherlands has designated parts of the Hond-Paap area as a special area of conservation under the Habitats Directive.

The role played by the Netherlands in the international consultations has been as follows:

Schiermonnikoog Declaration
Cooperation with the governments of Germany and Denmark will be reinforced and further developed, building on the Schiermonnikoog Declaration (2005) and the Trilateral Wadden Sea Plan (1997). Over the next few years, cooperation will mainly be geared towards coordinated and consistent implementation of EU Directives, with one aim being to clarify the situation from the point of view of inhabitants and stakeholders.
To this end, the co-management scheme will be updated, subject to the requirements of the EU Directives, with a view to incorporating the cultural/historical and landscape aspects.

Nomination for World Heritage List
Following the agreements reached on the Wadden Sea island of Schiermonnikoog in 2005, preparations are being made, in close cooperation with the population and interest groups, for the possible nomination of the Wadden Sea for inclusion on the UNESCO World Heritage List. The nomination of the Wadden Sea as a World Heritage Site would not result in a more stringent protection regime.

Treaties and agreements of the International Maritime Organization (IMO) and the OSPAR (Oslo-Paris) Convention
The relationship that has been established with regard to water quality between the Wadden Sea Policy, the North Sea Policy and the Rhine and Ems Policies will be continued and, where possible, reinforced. The European Water Framework Directive provides the means to reinforce the link between the Wadden Sea and Rhine and Ems Policies. Under the Water Framework Directive, the Wadden Sea (with the exception of the adjacent harbours and a 500-metre zone around them) has been provisionally designated as a ‘natural water body’. Exceptions have been made for the salt marshes and summer polders. The harbours, including a 500-metre zone around the harbour mouth, have provisionally been given the status of ‘heavily modified water body’. The Ems-Dollard area (extending from the mouth of the river Ems in the Dollard up to and including Eemshaven) has been provisionally designated as ‘heavily modified‘(in partnership with Germany). Eemshaven and the Zeehavenkanaal form part of this heavily modified water body. What is significant is that Germany and Denmark have also assigned the Wadden Sea the provisional status of ‘natural water body’. As in the Netherlands, this does not apply to the harbours and the large estuaries of such rivers as the Weser, Elbe and Ems. The WFD measures for the sea will be incorporated in the treaties and agreements of the International Maritime Organization (IMO) and the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR). Measures for shipping are only meaningful if they are agreed at a global level.

As far as emissions reduction is concerned, the agreements are aimed at upstream measures.

International cooperation
International cooperation under the aegis of the European Union, the Ramsar Convention, the Conventions of Bonn and Bern and the World Heritage Convention will be continued. Where possible and desirable, the cooperation will be intensified.

2.

Key policy principles

2.1 Objectives for the Wadden Sea

The main objective for the Wadden Sea is the sustainable protection and development of the Wadden Sea as a nature reserve and the conservation of the unique open landscape.
In order to achieve this, the policy is geared towards sustainable protection and/or ensuring that the following elements develop in as natural a manner as possible:

- the water flows and associated geomorphological and pedological processes;
- the quality of water, soil and air. Water and soil quality should be such that contaminants have only a negligible effect on flora and fauna;
- the flora and fauna;

and it is also geared towards conservation of:

- the landscape qualities – and, in particular, the tranquillity, vastness, open horizon and ‘naturalness’ (including darkness).

Other features to be protected are the archaeological assets that are present in the soil and the area’s cultural/historical assets.

The safety of the Wadden Sea Region’s inhabitants is ensured by good sea defences. Access to the harbours and the islands is safeguarded.

The essential qualities of the Wadden Sea (natural resources, horizon and coherence) present opportunities for economic development. The perception of the natural and landscape qualities of the Wadden Sea by the region’s inhabitants and visitors has served as a further point of reference during subsequent policy development.
Plans, projects or other interventions are possible on the basis of this PKB, provided they are compatible with the main objective for the Wadden Sea and conform to the assessment framework established in this PKB.

2.2 Development perspective for the Wadden Sea

The Dutch Cabinet is seeking to adopt a proactive and development-oriented strategy with regard to the Wadden Sea. The development perspective outlines the key long-term policy elements advocated by the Dutch Cabinet for the development of the Wadden Sea in the period up to 2030. It reflects the desire to achieve sustainable development of the area, both from an ecological standpoint and in socio-economic, touristic and recreational terms. The perspective therefore aims to meet the needs of the present generation without jeopardising our ability to fulfil the needs of future generations.
Government policy with regard to the Wadden Sea is geared to realising the development perspective for the Wadden Sea in the long term, while keeping within the parameters specified in section 2.1.

The key elements of the development perspective are as follows:

- The Wadden Sea is primarily a nature reserve and a unique open landscape. Disturbance of the natural dynamics of the physical processes that occur in the Wadden Sea, on the Wadden Islands and in the North Sea Coastal Zone will be kept to a minimum so that new mudflats, channels, dunes and coastal areas can develop. Tranquillity, vastness, open horizon and naturalness (including darkness) have been safeguarded and are highly valued.
- The water quality is such as to allow optimal development of flora and fauna.
- The flora and fauna are rich, varied and present in the same quantities as before the period of eutrophication.
- The area of natural salt marshes has increased.
- Disturbance to the seabed is limited to such an extent that mussel banks and sea-grass fields are able to develop naturally. The area of mussel banks (of natural density) and sea-grass fields has increased.
- Sufficient food, breeding sites and resting places have been ensured (in a sustainable manner) for marine mammals, fish and birds (migratory and resident).
- The free migration of aquatic organisms between the Wadden Sea and fresh inland water is guaranteed. Fresh-salt water gradients are present at several locations. Landscape and recreational aspects have consistently been taken into consideration when establishing new gradients.
- In the most extensively used parts of the Wadden Sea (especially the eastern Wadden Sea), the tranquillity has been permanently safeguarded.

- As far as possible, the Wadden Sea will remain protected against threats. The potential consequences of threats to the natural assets of the Wadden Sea will be minimised.
- The cultural/historical assets (i.e. the archaeological assets present in the soil and seabed and the cultural/historical elements and structures characteristic of the Wadden Sea Region) have been effectively preserved.
- Flood management has been handled in a sustainable manner. The primary flood defences still meet the requirements of the Flood Defence Act.
- The airlink between the islands and the mainland has been guaranteed in order to ensure the safety and health of the islanders. The peace and tranquillity of the Wadden Sea will be safeguarded by the requirement that aircraft may only fly above a certain altitude.
- Access to the harbours in and adjoining the Wadden Sea has been safeguarded.
- The economic activity in and around the Wadden Sea provides the population with work and income and is of a sustainable nature.
- A form of tourism has been achieved which is ecologically sustainable, economically viable and socially acceptable. The Wadden Sea Region provides an ideal experience of nature and landscape.
- The Wadden Sea harbours have developed in a manner that is both sustainable and reflects their specific location and potential. As far as the harbours are concerned, this has been achieved by each harbour specialising in different activities.
- The Wadden Sea is used for various forms of fishing in such a way as to allow the development of rich and varied fish stocks and prevent adverse effects on the remaining fauna and flora (including those inhabiting the seabed) and the landscape qualities of the Wadden Sea.
- Pollution caused by military activities has been reduced on the Wadden Sea.
- The traditional interests of the local population in the Wadden Sea Region have been safeguarded by practising various forms of small-scale, sustainable, historical exploitation of natural resources. This has contributed to the positive perception of the area.

The Regional Coordination Board for the Wadden Sea Region (RCW) will flesh out the development perspective of this PKB in the proposed integrated Plan for the Management and Development of the Wadden Sea Region by drawing up a target scenario and a frame of reference for the Wadden Sea.

The Dutch Cabinet is underpinning the development perspective by drawing up a 20-year investment plan to facilitate additional investment in the Wadden Sea Region. In order to finance the investment, a separate Wadden Fund is being established under the management of the Minister of Housing, Spatial Planning and the Environment. The Wadden Fund will receive €800 million from the government, spread over a period of 20 years. Activities that are deemed to be normal government duties are not eligible for a grant from the Wadden Fund.
An implementation plan is being drawn up in conjunction with the regional authorities. The implementation plan will identify the investment priorities for the next five years and therefore guide the phased implementation of the development-oriented and proactive strategy. After the administrative costs and the compensation payments to the cockle-fishing sector have been deducted, the additional investment will be directed at habitat restoration and development, threat reduction, sustainable economic development and

improvement of knowledge infrastructure. The objective of sustainable economic development is also fulfilled by activities that aim to achieve a substantial transition to sustainable energy management in the Wadden Sea Region and the adjacent areas of Friesland, Groningen and the North (*Kop*) of North Holland.

3. Policy choices

This chapter outlines the policy choices that the Dutch Cabinet considers important in order to realise the objectives for the Wadden Sea as indicated in section 2.1 and the long-term development perspective (as indicated in section 2.2). The policy choices have been broken down into measures directed at nature in a broad sense (including water, soil and air quality) and those directed at human activities. The latter measures consist of both existing and new human activities in the Wadden Sea Region and beyond (in so far as they have an impact on the Wadden Sea).

The main criterion applied in making the policy choices is that human activities have been permitted where they are compatible with the principal objective for the Wadden Sea.

The statements included in this chapter have undergone an appropriate assessment, in accordance with the Birds and Habitats Directives (as implemented in the 1998 Nature Conservancy Act since October 2005). This appropriate assessment was based on the provisional conservation objectives for the Wadden Sea (see Appendix 2), using knowledge of current policymaking and management practices. Current practices have also been a point of reference when assessing activities. The appropriate assessment has resulted in a number of adjustments being made to the PKB. Now that the results of the appropriate assessment have been incorporated, the PKB fulfils the conditions of the Habitats Directive and of the amended 1998 Nature Conservancy Act, which has been in force since October 2005. In addition to an appropriate assessment, ten statements included in this chapter have also undergone a strategic environmental assessment based on European Directive 2001/42/EC concerning “the assessment of the effects of certain plans and programmes on the environment”.
These assessments do not alter the fact that an appropriate re-assessment may be necessary once plans, projects and other interventions have been further fleshed out. Unless stated otherwise, the policy choices in this chapter relate to the PKB area.

3.1 Space for nature and landscape

The policy with regard to nature is aimed at ensuring that the ecosystem develops in as natural a manner as possible. A mobile coastline is possible at most extremities of the Wadden Islands. If natural processes are unable to restore the characteristic biodiversity in the medium-to-long term then selective intervention is possible. This intervention is then aimed at creating the right conditions to set in motion the natural processes that lead to characteristic biodiversity. For example, steps could be taken to restore fresh-salt water gradients or to conserve and develop the salt marsh areas by stimulating salt marsh formation and by de-embanking summer polders.
The EU Water Framework Directive and the Birds and Habitats Directives – as implemented in the Flora and Fauna Act and in the 1998 Nature Conservancy Act – serve as important assessment frameworks in connection with efforts to promote the natural development of the ecosystem. **The Cabinet is endeavouring to restore natural fresh-salt water transitions, one of the aims being to bring about a single**

natural fresh-salt water transition in the Wadden Sea Region for the Ems and Rhine river basin districts in addition to the existing natural fresh-salt water transitions. This can only be achieved if the plans also receive sufficient support from the regional agricultural and horticultural organisations.

In the first half of the PKB planning period, the Cabinet, mindful of climate change and rising sea-levels, will give further consideration to ways in which the maximum possible space can be given to natural processes. It will consult the relevant provinces, municipalities and district water boards about these measures.

Pollution of the Wadden Sea with contaminants and nutrients will be reduced in accordance with the national policy on water quality and North Sea Policy, with particular attention being focused on diffuse contaminants and national and international policy regarding air, soil and water. The long-term goal is to fulfil the targets for water and soil as set out in the Fourth National Policy Document on Water Management and to achieve 'good status' as defined in the Water Framework Directive. In the planning period for the Fourth National Policy Document on Water Management (up to 2006), efforts are being made to achieve the minimum quality level (i.e. the maximum acceptable risk level) for as many compounds as possible.
In consultation with the provinces and municipalities, the Dutch Cabinet is responsible for formulating an up-to-date and effective emergency plan to minimise the risk of pollutants finding their way into the Wadden Sea and the adjacent harbours, which will enable it to respond effectively to any disasters that might arise.

3.2 Space for human activities

a. Closed areas
In order to protect flora and fauna, parts of the Wadden Sea are closed for human activities for all or some of the year (see PKB map B). The areas concerned are updated annually pursuant to Section 20 of the 1998 Nature Conservancy Act. Exceptions can be made to this ban for activities that do not harm the protected flora and fauna.
Under trilateral agreements, an area has been created in the eastern part of the Wadden Sea within which exploitation of resources is prohibited. This serves as a reference area for scientific research (see PKB map B).

b. Land reclamation
No concessions will be awarded for land reclamation in the Wadden Sea or parts thereof.

c. Safety
In principle, human interventions aimed at safeguarding the inhabitants and users of the Wadden Sea Region are permitted.

d. Shipping
Water management activities, including the maintenance of shipping channels, are of limited extent, reflect natural morphological developments and only take place if access to the harbours or Wadden Islands or traffic safety is at stake.

Access to the harbours and islands is safeguarded by means of mooring facilities for ferries and target depths/standardisation for shipping channels. In both cases the 2006 target depths/standardisation (to be updated) apply. These state that vessels whose draught and dimensions allowed them to put in at the harbours at that time, given average sea level and wind conditions, must also be able to do so in the future. Economic and technical developments in the shipping sector are taken into account. Further periodic measures to deepen the main shipping channels are possible, in line with natural developments in the channel depth, providing this is compatible with the assessment framework established in the PKB.
In view of the economic potential of the harbours at Den Helder, Harlingen, Delfzijl and Eemshaven, it is possible that the shipping channels between these harbours and the North Sea may be further deepened, notwithstanding the stipulated target depths/standards, providing this is compatible with the assessment framework established in this PKB. In particular, the Harlingen-North Sea shipping channel will be deepened to at least 7.5 metres below Dutch Ordnance Level (NAP).

A maximum speed limit of 20 kilometres per hour applies for all motor vessels in the Wadden Sea, except in a number of buoyed shipping channels and the existing high-speed zone near Oudeschild and for genuine rescue, recovery, search and patrol operations, and also for associated rescue and military exercises. Further navigation restrictions may be introduced for parts of the Wadden Sea that are in particular need of conservation on account of their scientific assets.

The government will be responsible for buoying and beaconing the shipping routes in the Wadden Sea. The buoyed shipping channels, the high-speed routes and the high-speed zone near Oudeschild are shown on PKB map B.

The use of hovercraft is not permitted in the Wadden Sea.

e. Civil aviation
Civil aircraft must observe a minimum altitude of 450 metres over the Wadden Sea. A minimum altitude of 450 metres will likewise be introduced for civil aircraft over the remainder of the Wadden Sea Region, except for the terrestrial areas of the mainland municipalities.

Exceptions are only possible in specifically defined circumstances. Only if the cloudbase or poor visibility prevents flying above 450 metres will a minimum altitude of 300 metres (1000 feet) – or as far above this height as possible – be observed in the corridors. See explanatory map 14. **No aerial advertising flights may be conducted over the Wadden Sea and the remainder of the Wadden Sea Region (except for the terrestrial areas of the mainland municipalities), with the exception of flights from Texel airfield directly to the mainland and vice versa.**

No new airfields may be constructed in the Wadden Sea and the remainder of the Wadden Sea Region. Expansion of existing airfields in the Wadden Sea Region (except for the terrestrial areas of the mainland municipalities) will only take place in the interests of aviation safety and provided it is compatible with the assessment framework established in this PKB.

f. Offshore installations

No drilling rigs or other offshore installations may be sited in the Wadden Sea. The Cabinet will make an exception for the existing temporary site in the 'Gat van de Stier' channel between Den Helder and Texel. Pending the completion of maintenance and repair works in Den Helder harbour, a maximum of two offshore installations may be sited at this location for no more than three months per year. In emergencies only, three offshore installations may be temporarily sited here and the time limit may be extended, once only, and by no more than three months. **This temporary facility will be completed within three years, starting from the entry into force of this PKB. The Cabinet will provide an alternative location outside the Wadden Sea for the siting of drilling rigs and other offshore installations.**

g. Cables and pipelines

The laying of cables and pipelines through the Wadden Sea should be assessed on a case-to-case basis. As a rule of thumb, these should link up with existing cable and pipeline routes, which are shown in explanatory map 15.

h. Harbours and industrial sites

No new harbours and industrial sites may be constructed in or directly adjoining the Wadden Sea. Existing harbours and industrial sites directly adjoining the Wadden Sea (except for Den Helder) must not be extended seawards. A seawards extension is possible in Den Helder in the event that the TESO ferry harbour is relocated, providing a careful planning assessment is conducted. An exception will also be made for limited extensions to those Wadden Island harbours that are intended for leisure craft, if these should be necessary for safety or certain other reasons and no appropriate alternative solution is available. The agreement referred to in 3.2 o of this PKB is determinative in cases of this kind. Any exceptions must be compatible with the assessment framework that is outlined in this PKB.

As far as a possible new extension to the harbour at Harlingen is concerned, preference will be given to a landwards extension. However, if a specific plan that is underpinned with research should give rise to the view that a seawards extension is feasible at Harlingen within the parameters of the assessment

framework established in the PKB, the Cabinet will make this possible by undertaking a partial revision. The planning assessment will have to be conducted on the basis of the above-mentioned research, taking account of the landscape and cultural/historical and natural assets of both the Wadden Sea and the area lying inside the dike.

Aside from the exceptions referred to above, extension of harbours and industrial sites is only permitted to the landward side. Seawards construction or modification of breakwaters and ferry causeways is not normally allowed, unless it is required for reasons of safety or accessibility – in which case it must be compatible with the assessment framework established in this PKB. Explanatory map 16 shows the harbours and the larger industrial sites directly adjoining the Wadden Sea. PKB map B shows the marinas.

Development opportunities may be exploited on industrial sites in the vicinity of the Wadden Sea on the condition that national environmental-health standards are fulfilled and that high-risk enterprises and/or substances are permitted provided it is shown that no irreparable damage can be inflicted on the Wadden Sea in the event of disasters.

i. Building works

No buildings may be erected or sited in the Wadden Sea, except for:
- ***temporary buildings erected for the purposes of scientific research and monitoring;***
- ***structures necessary to the safety of the shipping in the Wadden Sea;***
- ***structures providing alternative seed mussel sources;***
- ***structures providing effective drainage of the mainland;***
- ***observation posts; and***
- ***the exceptions to the ban on seawards harbour extensions (see 3.2h of this PKB).***

New building works may only take place in the vicinity of the Wadden Sea within the parameters of national spatial planning policy. Their height should be in keeping with the existing buildings and buildings in the outlying area should blend in with the character of the surrounding landscape. An exception to the height stipulation will be made for the harbour-related and urban buildings in Den Helder, Harlingen, Delfzijl and Eemshaven. Even in the case of these exceptions, new buildings must, as far as possible, be blended into the existing skyline.
Furthermore, structures for the exploration and extraction of gas from beneath the Wadden Sea are subject to the conditions listed in section k (“Deep-lying minerals”).

“Building works” is understood to mean all buildings and structures with the exception of wind turbines.
The Cabinet will endeavour to prevent loss of night-time darkness due to large-scale light pollution (e.g. from greenhouse complexes).

j. Dredging spoil

Only dredging spoil originating from the Wadden Sea and the directly adjacent harbours may be deposited in the Wadden Sea. This dredging spoil should comply with the current quality standard according to national water management policy.

The dumping of dredging spoil in the Wadden Sea is subject to guidelines aimed at minimising impact on the ecosystem and other human activities. The government will ensure that the dumping sites are ideally located from an ecological standpoint.

k. Deep-lying minerals

New exploration and extraction of deep-lying minerals is not permitted at locations in the Wadden Sea.

New exploration and extraction of gas from beneath the Wadden Sea can take place subject to the following conditions:
- New exploration and extraction of gas is only permitted from terrestrial locations and from existing platforms in the North Sea (coastal zone).
- Providing there is no reasonable scientific doubt as to the absence of adverse effects on the natural assets and features described in this PKB.
- An independent body advises the competent authority on the planning, execution and policy implications of proper monitoring of all relevant effects and developments, so that the competent authority can, if necessary, intervene in accordance with the 'hand on the tap' principle.
- The requisite buildings (including the temporary siting of drilling installations) will be blended into the landscape as carefully as possible and using the best available technology in order to protect its unique openness.
- In view of this careful integration into the landscape, the temporary use of exploration, maintenance and extraction installations is not considered to be detrimental to open horizons and darkness.
The above provisos will be further elaborated in extraction and measurement plans, as stipulated in the Dutch Mining Act and in permits issued under the 1998 Nature Conservancy Act.
Explanatory map 17 shows the areas where permits are required and the existing locations for the extraction of gas from beneath the Wadden Sea.

The Cabinet will not be issuing any new permits for exploration and extraction of other deep-lying minerals from beneath the Wadden Sea (i.e. deep-lying minerals other than gas) until such time as it has been scientifically established beyond reasonable doubt that such activities do not adversely affect the natural and landscape assets of the Wadden Sea.

It is prohibited to discharge any waste materials (including drilling spoil) into the Wadden Sea.

l. Wind turbines

The siting of wind turbines in the Wadden Sea is prohibited. The acceptability of siting wind turbines in the vicinity of the PKB area will be assessed on a case-by-case basis by applying the criteria that are specified in the national spatial planning policy and in the assessment framework for this PKB.

m. Excavation

The extraction of sand from the Wadden Sea is confined to the sand released during the regular maintenance of shipping channels and during periodic further deepening of parts of the main shipping channels and sand released during excavations for building works specified as an exception in section 3.2 i.

The harvesting of shellfish in the Wadden Sea is regulated by means of a quota system and zoning. See explanatory map 18. **The volume of shellfish harvested annually in the Wadden Sea and the outer deltas of the adjacent North Sea Coastal Zone must not exceed the long-term average natural shellfish production, with a maximum of 90,000 m^3 per year being caught in the PKB area. Shellfish harvesting is only permitted below NAP (Dutch Ordnance Level) minus 5 metres.**

n. Archaeology
Surveying and recovery of archaeologically valuable shipwrecks and submerged and silted-over settlements in the Wadden Sea may be permitted (subject to certain provisos) if these come to the surface of the seabed through the action of natural physical processes. Investigation of archaeological assets that does not disturb the seabed and does not otherwise damage the assets and features of the Wadden Sea that are to be protected and conserved is permitted subject to certain provisos. Human activities in the Wadden Sea must not result in damage to archaeological assets that are present in the seabed. Explanatory map 19 shows known locations of shipwrecks.

o. Recreation
Government policy with regard to recreation on the Wadden Sea is aimed at securing and maintaining control over recreational exploitation and developing sustainable forms of recreation, taking as its basic premise the natural resilience of the area. Recreational exploitation is governed by a zoning system which spares the areas that are susceptible to disturbance. A map with a broadly considered recreational zoning system is included in the appendix to this PKB (PKB map B).

No new marinas may be constructed in or directly adjoining the Wadden Sea.

At the initiative of the Wadden Provinces, an agreement is being drawn up between the government, the Wadden Provinces and the Wadden Municipalities. This includes an integrated policy aimed at securing and maintaining control over recreation and tourism on the Wadden Sea. If the agreement has not yet come into force by 31 December 2007 and it still proves necessary to adopt a capacity-related policy for marinas, the Cabinet will partially revise this section of the PKB.

The Wadden Sea must not be used for waterskiing, jetskiing and similar motorised activities, apart from the existing high-speed zone near Oudeschild. The existing high-speed zone near Den Helder is being closed.

The Wadden Provinces are requested to flesh out the recreational policy for the Wadden Sea in the light of this PKB.

p. Fishery

Mussel fishery
Mussel farming will be enabled to implement several innovative plans on an experimental scale, and under the supervision of researchers, that will assist in the harvesting of seed mussels from alternative sources, or harvesting using alternative methods.
These include plans involving the harvesting of seed mussels from anchored nets, ropes and poles. If research shows that this form of seed harvesting offers ecological and

economic benefits compared with traditional seed mussel fishery then it will be possible to scale up to commercial application. During this process, consideration should be given to other human activities (such as shipping, recreation and other fishing) and to the conservation of the unique landscape.

The designation of temporary experimental areas for the sowing of seed mussels (maximum area: 500 ha) has been authorised with a view to optimising mussel beds. The total size of the cultivation beds will be maintained and will not be further increased (see explanatory map 20).

Seed mussel fishery must only take place in the spring and autumn, based on a monitored fishing plan. The seed mussel fishery that takes place in the sublittoral zone in the autumn now focuses only on the unstable stocks. The spring fishery in the sublittoral zone is confined to the open areas.
The mussel sector should clearly demonstrate that its activities result in mussel stocks that are at least equal in size to the mussel numbers that might have been present in a natural situation.

To accomplish this, the mussel sector will have to demonstrate that at least 85% of the total seed mussel harvest from the spring fishery is still present in the Wadden Sea the following winter, after deducting the amount harvested in the autumn preceding the spring fishery. If more than 2000 hectares of long-term mussel banks are present *and* there is no reasonable scientific doubt as to the absence of adverse effects on the natural assets and features described in this PKB, then fishing of unstable mussel seed banks on the mudflats will be permitted subject to certain provisos.
Exceptions may be made to the above stipulations for fishing of mussel and mussel-seed banks in connection with research into the hypothesis that controlled fishing increases the stability of the mussel bank.

Cockle fishing
Mechanical cockle fishing in the Wadden Sea has been prohibited since 1 January 2005. Non-mechanical cockle fishing is still allowed. An increase in the number of permits for non-mechanical cockle fishing is under consideration. Non-mechanical cockle fishery must account for no more than 5% of the annual Wadden Sea cockle stocks.

Shellfish fishing in general
Manual collection of shellfish for personal use is permitted, subject to a maximum catch of 10 kg per person per day.
A small-scale experiment is being started with the commercial collection of Japanese oysters. **The commercial collection of mussels is prohibited.**
Initiatives seeking to cultivate shellfish species other than mussels, and also innovative experiments including the cultivation of shellfish on the landward side of the dikes, will be assessed for compatibility with the existing frameworks.

Closing areas to certain forms of fishing
Twenty-six per cent of the littoral zone in the Wadden Sea is permanently closed to bottom-contacting fishing methods (seed mussel fishery, cockle fishing and fishing using bottom-contacting fishing gear with tickler chains). See explanatory map 20.
Shrimp fishery is not permitted on the tidal flats (the littoral zone) in the areas that have been closed to bottom-contacting fishing methods. Fishing with other types

of trawl net (with or without tickler chains) is not permitted on the tidal flats (the littoral zone) anywhere in the PKB area.
This may be considered if a clear benefit can be achieved for nature and for the shellfish sector by adjusting boundaries or exchanging closed areas with open areas. Some areas of the sublittoral zone may be closed to bottom-contacting fishing methods and shrimp fishery for the purposes of long-term research.
Fishing is prohibited in sea-grass fields and within a radius of at least 40 metres around them. Fishing is also prohibited in stable littoral mussel banks and within a radius of 40 metres around them. Exceptions to this ban may be made for the fishing of mussel banks (and mussel seed banks) in order to investigate the hypothesis that controlled fishing improves the stability of the mussel bank. If the research shows that this form of fishing does not adversely affect the stability of the mussel banks and other ecosystem assets then further consideration will be given to the conditions and locations in which this form of fishing can be permitted.

Trawling
So long as there is no evidence that trawling (with or without tickler chains) in the sublittoral zone has significant ecological effects on the sublittoral system, this form of fishing will continue to be allowed. **However, there will be no further increase in the number of permits. Anyone who has already reserved a permit for more than one year without possessing a vessel that is suitable for trawling will have their reservation cancelled, together with their entitlement to a permit.**

Fixed fishing gear
Fishing with fixed fishing gear will be regulated through the introduction of controlled fishing areas (*visvakken*) or via the standard permit requirements. There are no plans to declare new controlled fishing areas in the Wadden Sea. Fishing on the tidal flats with bottom-set gillnets will be curbed in order to further reduce the numbers of birds drowned in these nets, unless this fishing can be carried out in a way that minimises the drowning of birds and by-catch of marine mammals in these nets. Elsewhere in the Wadden Sea, studies will be conducted on ecological compatibility.

q. Military activities
The Cabinet does not believe that it is realistic to substantially reduce military activities in the Wadden Sea Region or to stop them altogether. The existing activities are considered to be of such importance to society that they will be continued at the existing locations during the planning period and steps must be taken to ensure that they can be carried out efficiently.
In the event that the Cabinet should, for some reason, no longer consider the activities to be necessary, they will be halted.

In order to reduce environmental pollution in the Wadden Sea, the Cabinet has decided to make the following changes to existing military activities:
- The section over the Wadden Sea has been removed from the low-flying route for fighter aircraft.
- The minimum altitude for military aircraft over the Wadden Sea has been raised from 300 metres to 450 metres. Flights with military helicopters and the various approaches to the Vliehors shooting range are exempted from this measure.
- Whenever possible, planes will approach the Vliehors shooting range from the North Sea instead of flying over the Wadden Sea.
- The tank training camp on Vlieland has been taken out of service.

Explanatory map 21 shows the military activities in the Wadden Sea Region.

r. Lugworm extraction
The number of permits issued for the mechanical extraction of lugworms must not be increased. The permits for this activity will only be issued to current permit-holders and are not transferable. Explanatory map 22 shows the designated areas for mechanical lugworm extraction.

4.

Assessment framework

4.1 Assets and features designated for protection and conservation
The assets and features that have been designated for protection and conservation under this PKB are a direct corollary of its principal objective. Some are assets and features that the Netherlands is required to protect and conserve under the Birds and Habitats Directives, the 1998 Nature Conservancy Act and the Flora and Fauna Act, while others are the assets and features that the Cabinet considers to be of such great importance that they too are worthy of continued protection and conservation.

Pending the establishment of a definitive conservation objective, a provisional goal has been formulated as a general qualitative conservation objective, based on the Birds and Habitats Directives. This has been included in Appendix 2. More specifically, this conservation objective, which has been broadly formulated using qualitative terms, relates to the maintenance of the favourable conservation status of the qualifying habitats and species, which are also listed in Appendix 2.

Decisions are made on concrete projects and activities after the decisions on designated areas have been formulated or supplemented pursuant to Section 10a of the 1998 Nature Conservancy Act. The assessment of these projects and activities must be based on the definitive conservation objectives.

For the purposes of this PKB, assets and features designated for protection and conservation are understood to mean:
- water flows and the associated geomorphological and pedological processes;
- natural bed relief;
- quality of water, soil and air;
- biological processes, including migration possibilities for animals;
- area-specific plant and animal species;
- foraging, breeding and resting areas for birds; whelping, resting and nursing areas for marine mammals; and nurseries for fish;
- landscape qualities, notably tranquillity, vastness, open horizon and naturalness (including darkness);
- the presence of archaeological assets in the soil and cultural/historical assets in the area.

4.2 Assessment framework
Plans, projects and other interventions are possible provided they are compatible with the policy frameworks and objectives that have been formulated for the Wadden Sea, as established in this PKB.
The competent authority must take into account all assets and features specified in section 4.1 when assessing plans, projects and other interventions (providing this is not incompatible with statutory regulations).

This assessment framework does not remove the need to comply with other statutory requirements.

Natural assets
Plans, projects and other interventions should be subjected to the assessment frameworks of the European Birds and Habitats Directives, which were nationally implemented in the 1998 Nature Conservancy Act and the Flora and Fauna Act.

The protection of the natural assets and features of the Wadden Sea is subject to the assessment framework laid down in the 1998 Nature Conservancy Act. A central element of this Act is the so-called habitat test. According to this test, an appropriate assessment must be conducted for plans, projects or other interventions if, on the basis of objective data, these could conceivably have significant implications for the Wadden Sea (either separately or in combination with other activities). The appropriate assessment describes the effects of the proposed plans, projects and other interventions on the conservation objectives for the protected habitats and species within the Wadden Sea area (as designated in Natura 2000). If, based on the results of the appropriate assessment, there is no reasonable scientific doubt that the natural features of the Wadden Sea, as defined in the 1998 Nature Conservancy Act, will not be adversely affected, then consent may be granted for the activity. If this is not the case, consent can only be granted in the absence of alternative solutions, based on arguments relating to human health, public safety or extremely favourable environmental effects. Other imperative reasons of overriding public interest (including those of a social and economic nature) can also be cited, but then advice is first required from the European Commission. If a plan, project or other intervention is permitted in principle after the importance for nature conservation and imperative reasons of overriding public interest have been considered, then any compensatory measures necessary to protect the overall coherence of Natura 2000 must be secured.

In the interests of species protection, the assessment framework laid down in the Flora and Fauna Act is also applicable. This Act implemented the species protection component of the Birds and Habitats Directives. By means of the prohibitory provisions in Sections 8–18, the Act affords protection to the designated protected plant and animal species, the habitats of protected plants, and the nests, other breeding sites and resting and denning sites of protected animals. Section 75 of the Flora and Fauna Act is of particular relevance to plans or projects that relate to threatened plant or animal species. Under certain circumstances, such initiatives may be granted exemption or release from the general prohibitory provisions of the Act, providing the favourable conservation status of the species concerned is not in doubt.

Landscape assets
The competent authority will have to conduct the same assessment with regard to the landscape qualities specified in section 4.1 as for the natural assets, providing this is not incompatible with statutory regulations.

Archaeological assets
Archaeological assets present in the soil are subject to the protection regime laid down in the Monuments and Historic Buildings Act.

Water quality

Water quality is also subject to the assessment framework laid down in the Water Framework Directive. The aim of the Water Framework Directive is to secure and maintain the good status of European waters, based on coordination of water management at river basin-district level. The river-basin-district management plan is an important instrument. The Dutch part of the Wadden Sea is part of the river basin districts of the Ems and Rhine.

The Water Framework Directive aims to achieve a good ecological and chemical status in the Wadden Sea by 2015. The term ‘good status’ will be further fleshed out with concrete goals for different aspects.

The acceptability of plans, projects or other interventions should be assessed by the various competent authorities in a consistent fashion. Provinces and municipalities in the Wadden Sea Region should therefore conduct the appraisal in the manner specified in this section. Furthermore, they should ensure that this is reflected in their regional and land-use plans in so far as these relate to the Wadden Sea. If more agencies are involved in the decision-making process as competent authorities, the Cabinet believes it would be desirable to coordinate decision-making and harmonise procedures.

5. Impact and evaluation of the Wadden Sea Policy

5.1 Impact of the policy

The Cabinet will ensure that the policy statements made in this PKB are fulfilled. Provinces and municipalities should take these policy statements into consideration when revising their spatial plans. Policy statements that have been designated as concrete policy decisions must be directly reflected in these plans.

An integrated Plan for the Management and Development of the Wadden Sea Region (the “B&O plan”) will be drawn up in order to implement the PKB policy in a coordinated and coherent fashion. If possible, the government intends to incorporate the Wadden Sea-related management plans that are produced under the 1998 Nature Conservancy Act and the Water Framework Directive into this B&O plan. The B&O plan will be revised at least once every six years.
Periodically, a Programme of Measures for the Wadden Sea will be drawn up, based on the B&O plan, in which the authorities outline the measures and actions that they propose to take over the next six years. In addition, a Report on the Programme of Measures for the Wadden Sea will be published at regular intervals, reporting on the implementation of the programme of measures. Finally, a Wadden Sea Enforcement Programme will be produced, specifying the way in which the policy is to be enforced. These plans will be assessed by the parties represented in the Regional Coordination Board for the Wadden Sea Region (RCW).
Responsibility for the implementation of the B&O plan, the programme of measures and the enforcement programme rests with the relevant competent authority. The Cabinet believes that proper enforcement of the policy set out in this PKB by the competent authorities is an essential prerequisite for the success of the Wadden Sea Policy. The RCW will be responsible for coordinating enforcement of the programmes.
Inhabitants and interest groups will be expressly involved in the implementation of the policy.

Due weight must be given to the mitigation measures specified in the appropriate assessment and strategic environmental assessment of this PKB when issuing permits. Furthermore, the results of the appropriate assessment and strategic environmental assessment must be taken into consideration when the programme of measures for the above-mentioned B&O plan is established.
The Cabinet regards public information and education as important prerequisites to the realisation of the Wadden Sea Policy. In the Wadden Sea Region, public information is primarily aimed at broadening public support for the policy and providing clarification. As far as education is concerned, the government plays a facilitating role. Government agencies make the maximum possible use of the nature-conservation and environmental organisations and visitor centres when communicating policy and public information. The government does not, however, have any formal input into the running of nature-conservation and environmental organisations or visitor centres.

In the first half of the planning period for this PKB, the government will consider the possibility of adopting a “one-stop” approach to the granting of consent or permits in consultation with the Wadden authorities.

Pursuant to Section 15a of the 1998 Nature Conservancy Act (and in the light of the Birds Directive values) the conservation objectives for the Wadden Sea special protection area (as designated in the Birds Directive) are partly aimed at conserving, restoring and developing the scientific value and natural beauty of the Wadden Sea, as previously laid down in the decree designating the Wadden Sea as a protected natural monument (*staatsnatuurmonument*). In the 1998 Nature Conservancy Act, the Wadden Sea was designated as a special protection area under the Birds Directive and as a special area of conservation under the Habitats Directive.

5.2 External effect

Realisation of the objectives that have been formulated for the Wadden Sea is partly dependent upon the extent to which nature and other functions are allowed to develop outside the PKB area – especially in view of the complex web of ecological relationships. The Cabinet will adopt a proactive policy in this regard and urges the other authorities to follow its example.

Any plans, projects or other interventions outside the PKB area which, based on objective data, might conceivably have significant repercussions (either separately or in combination with other such initiatives) for the assets and features of the Wadden Sea that are to be protected and conserved under this PKB should be reviewed for compatibility with the main objective of this PKB.

This review is to be conducted using the assessment framework outlined in chapter 4.

This PKB is an important point of reference when formulating policy for water systems connected to the Wadden Sea (e.g. the North Sea and the Rhine and Ems river basin district).

This external effect will mainly be of relevance to new plans and additions or modifications to existing plans, projects or other interventions in the part of the Wadden Sea Region that is situated outside the PKB area.
These may include the following plans, projects or other interventions:
- activities in the Wadden Sea that give rise to noise pollution as a result of proposed commercial development, defence activities, hunting or other activities;
- laying of cables and pipelines in the vicinity of the PKB area;
- dredge-spoil dump site in the vicinity of the PKB area;
- proposed commercial development in the vicinity of the PKB area which poses a threat to water quality in the Wadden Sea;
- impairment of the characteristic open horizon as a result of the proposed installation of wind turbines and high, permanent structures in the vicinity of the Wadden Sea;
- construction of harbours and marinas in the vicinity of the PKB area;
- fishing activities in the waters directly adjoining the PKB area;
- extraction of minerals (deep and surface) in the vicinity of the Wadden Sea;
- building works in the North Sea that affect the Wadden Sea;
- activities in the Wadden Sea that cause light pollution (e.g. large-scale greenhouse complexes in the vicinity of the Wadden Sea).

In view of the possible effects on the Wadden Sea, policy statements have also been made in chapter 3 of this PKB that relate to areas beyond the boundaries of the PKB area, since they have a bearing on the realisation of the main objective for the Wadden Sea. Thus the external effect has already been operationalised for a number of plans, projects or other interventions.

5.3 Knowledge, 'nature boundaries', monitoring and evaluation

Knowledge management
Government policy with regard to knowledge concerning the Wadden Sea and the Wadden Sea Region is aimed at the effective management of knowledge concerning the natural and man-made landscapes and socio-economic development in the Wadden Sea and the Wadden Sea Region.
The Cabinet believes that there is a need for research in several fields and that integrated planning and prioritisation are extremely important. Cooperation between the research facilities concerned needs to be optimised and the responsibility for this task lies primarily with the various research institutes.

However, the Cabinet also believes that there is a proactive and coordinating role here for an independent "Wadden Academy", which should lead to improvements in:
- the articulation of research questions;
- the coordination of research planning;
- communication of knowledge and research findings.

The Cabinet envisages a future Wadden Academy as a small, efficient organisation which, wherever possible, will utilise existing infrastructure and links with centres of expertise and channels of communication when carrying out its coordinating activities. As far as knowledge management is concerned, existing responsibilities (financial and others) will remain unchanged. Government research funding will continue to flow through the existing channels and implementation will remain in the hands of the research facilities. The Wadden Academy will be set up within the framework of the Wadden Fund.

Nature and landscape boundaries
After consulting experts, the Cabinet concludes that a system of strict, predefined 'nature boundaries' (*natuurgrensen*) for all economic developments is not feasible in the short term – and, by the same token, nor are 'landscape boundaries'. Although the Cabinet is still interested in this approach, it does not anticipate using it during the planning period. The current system – whereby the Wadden Sea PKB sets general parameters for human exploitation of the Wadden Sea (and beyond, based on the external effect), supplemented by a case-by-case assessment at the time permits are issued – will be continued during the planning period. This system requires:
- effective monitoring of the Birds & Habitats Directive parameters and of human activities;
- introduction of "hand on the tap" principles, together with timely feedback mechanisms, so that an activity can be halted or restricted if necessary;
- and, finally, steps to ensure that gaps in knowledge are filled.

A more detailed investigation will be conducted to establish what additional research is required and to explore the legal feasibility of these nature and landscape boundaries. It

will therefore be possible to make a definitive judgement about the feasibility of this new system halfway through the planning period.

The *Verbetering kennishuishouding Waddenzee* [Wadden Sea Knowledge Management Improvement] project, which was conducted by the National Institute for Coastal and Marine Management (RIKZ) and the National Reference Centre for Agriculture, Nature and Food Quality (EC-LNV) in 2004, highlights the principal gaps in our knowledge, which are:
- the long-term development of the Wadden Sea in the light of anticipated climatic changes;
- a number of morphological and ecological processes are still not fully understood (and likewise the interaction between morphology and ecology);
- the relationship between decreasing eutrophication and the resilience of the system;
- insufficient knowledge about dose-effect relationships;
- knowledge of socio-economic and sociocultural factors is insufficient to allow for a social cost-benefit analysis (SCBA).

Monitoring
As far as monitoring is concerned, it is important to draw a distinction between general monitoring (aimed at assessing the overall status of the Wadden Sea) and specific monitoring, which aims to detect the effects of specific activities.
Monitoring must, in any case, be conducted in accordance with predefined and verifiable procedures, using data that are clear, unambiguous and properly interpreted.

As far as general monitoring is concerned, the Cabinet does not believe that any organisational changes are required, but feels that improvements are needed with regard to the interrelatedness of the monitoring programmes for the different activities (both at the national and international level).
The objectives will be further operationalised into measurable and verifiable indicators in the course of the planning period.
Plans, projects or other interventions of a scientific-research and monitoring nature that set out to ensure the effective management of the Wadden Sea ecosystem are, in principle, permitted. The trilateral monitoring and assessment programme will be implemented. Under the existing trilateral monitoring arrangement, a Quality Status Report (QSR) is produced once every four years. The underlying data are available for the purposes of identifying trends, together with the other national monitoring data. It has been agreed at trilateral level to optimise the ‘Trilateral Monitoring and Assessment Programme’ on the basis of an evaluation conducted in 2004. This optimisation process is aimed, in part, at bringing the programme into line with the Birds and Habitats Directives and the Water Framework Directive.

As far as specific monitoring is concerned, the Cabinet believes that a separate and independent monitoring committee would be desirable for extensive, politically sensitive activities (such as gas extraction), unless a system of predefined ‘nature and landscape boundaries’ is available. The Cabinet will decide on a case-by-case basis whether specific monitoring is required. This independent committee will not interfere with the responsibilities of the competent authority. The competent authority is responsible for imposing specific requirements with regard to monitoring, supervising monitoring activities *and* deciding, based on the results of the monitoring activities, whether – or to what extent – a given activity can be continued. The task of the independent committee is to conduct audits and advise the competent authority at crucial moments in the

process (i.e. when the monitoring requirements are formulated and when the results are released).

When specific monitoring activities are carried out, particular attention must be paid to continuity, cumulative effects and developments in adjacent areas.
Despite the conclusion reached in the appropriate assessment that this PKB was unlikely to have any significant effects, it has been ascertained, based on the relevant impact matrices, that certain species – namely birds and seals – are, in fact, affected in various ways. These effects may be local or supra-local and they are usually of a temporary or periodic nature. Continuous effects are rare. After seals and birds, the habitat types most affected are ‘permanently submerged sandbanks’, ‘intertidal estuarine mudflats and sand flats’ and ‘estuaries’. These too are, for the most part, local and supra-local effects of a temporary or periodic nature. The sensitivity of these species and habitats will need to be taken into account when monitoring the Wadden Sea.

Strategic environmental assessment has shown that there is no system for monitoring noise and light, notwithstanding the assertions made in the PKB with regard to tranquillity and darkness. These aspects will therefore also have to be taken into consideration when further improvements are made to the monitoring of the Wadden Sea.

Evaluation
Before the end of the planning period, the Cabinet will indicate whether or not the PKB is to be revised, retained or withdrawn. If it is revised (either completely or in part), the Cabinet will indicate which elements of the policy need to be adjusted and in what respect. Before this takes place, the policy will be evaluated. Among the factors to be taken into account during this evaluation will be the results of the studies announced in this PKB.

6.
Administrative organisation

The Cabinet regards effective coordination of policy-making and implementation as essential to the success of the Wadden Sea Policy.
The coordination of key strategic elements of the Wadden Sea Policy takes place within the Coordination Board for the Wadden Sea Region (CCW), whereas these key strategic policy elements are formulated by the Regional Coordination Board for the Wadden Sea Region (RCW). Both of these bodies include representatives of government, the Wadden Provinces, the coastal municipalities, the Wadden Islands and the district water boards. This organisational structure does not encroach upon the responsibilities of the individual parties.
The authorities concerned will define the role, position and working methods of both bodies, either in the form of a protocol or new terms of reference.

The CCW is chaired by the Minister of Housing, Spatial Planning and the Environment, whose portfolio includes responsibility for the Wadden Sea Policy. The CCW will meet once or twice a year. The CCW is the consultative body with responsibility for:
- revision of the Wadden Sea PKB;
- the closing stages of preparations for international and trilateral activities;
- matters that are not resolved within the RCW;
- the awarding of contracts and adoption of the Plan for the Management and Development of the Wadden Sea Region (B&O plan), including discussion of the Programme of Measures for the Wadden Sea Region.

The RCW is chaired by a Queen's Commissioner from one of the Wadden Provinces. The RCW performs various roles in its capacity as the linchpin in the implementation of the Wadden Sea Policy:
- drafting and implementation of the B&O plan;
- a coordinating role (e.g. in relation to enforcement);
- a forum for all matters relating to the Wadden Sea.
Specific problems relating to the Wadden Sea Policy are assigned to individual members of the RCW known as *regisseurs* (rapporteurs), according to their subject matter. In seeking solutions to these problems, the RCW should operate as a collective entity. The Board is supported by a small but highly qualified secretariat.

Being the principal activity on the agenda for the Wadden Sea, nature conservation will enjoy a pre-eminent status within the RCW and hence also within the proposed Wadden Sea Management Board (*Beheerraad*). Membership of the *Beheerraad* will consist of land-management organisations, including government departments such as the Ministry of Transport, Public Works & Water Management and the Department of Waterways & Public Works. The principal tasks of the Management Board will be to improve coordination between the respective land managers and thereby boost their collective efficiency. Its goal will be to harmonise land management activities throughout the Wadden Sea Region.

As the implementing instrument of the PKB, the B&O plan will play a crucial role in the Wadden Sea Policy. The CCW will instruct the RCW to draw up the B&O plan, which it will subsequently adopt, thereby giving shape to the link between the Cabinet and the B&O plan. The modular design of the B&O plan enables it to remain flexible and to anticipate new developments and decisions.

Annex 17

Act for amendment of the Act on the National Park "Wadden Sea of Lower Saxony" of 11 July 2001. (Law Gazette of Lower Saxony (Nds. GVBl.) p. 443 – VORIS 28100 05, 28100 01, 28100 03)

Act

For amendment of the Act on the National Park "Wadden Sea of Lower Saxony"

Of 11 July 2001

(Law Gazette of Lower Saxony (Nds. GVBl.) p. 443 – VORIS 28100 05, 28100 01, 28100 03 –)

The State Parliament (Landtag) of Lower Saxony has approved the following Act:

Article 1

Act on the "Wadden Sea of Lower Saxony" National Park

Section 1

Placement under protection

The "Wadden Sea of Lower Saxony" National Park, whose extent and boundaries are specified in the present Act, is located in the Wadden Sea between the Elbe River and Ems River estuaries.

Section 2

Protection purpose

(1) [1]The national park has the purpose of preserving and protecting the Wadden Sea's unique natural assets and landscape, including the characteristic appearance of its landscape, in the Wadden Sea region off Lower Saxony's coast. [2]The natural processes in these habitats are to remain in force. [3]The diversity of the plant and animal species in the territory of the national park is to be conserved. [4]For biotopes within the meaning of Article 20 c of the Federal Nature Conservation Act, the national park shall provide the necessary protection under the Federal Nature Conservation Act. [5]The special protection purposes of the various areas within the core zone are listed in **Annex 1**.

(2) [1]The areas of the national park declared, in Sentence 2, to be a European Special Protection Area, for implementation of Council Directive 79/409/EEC of 2 April 1979 on the Conservation of Wild Birds (OJ EC L 103 p. 1), in the applicable valid version, shall also serve the purpose of assuring the survival and increase of the bird species that occur in them and that are listed in Annex I and Article 4 (2) of the Directive. [2]The Special Protection Area within the meaning of Sentence 1 shall comprise all of the national park's areas, with the exception of the recreation zone above the mean high-tide line, of core-zone section I/50, of the peripheral Geest areas between Sahlenburg and Berensch and of core-zone section I/12 north of the line between the coordinates 6° 34' 51" E, 53° 41' 54" N and 7° 00' 00" E, 53° 45' 24" N.

(3) [1]The areas of the national park referred to, in Sentence 2, for implementation of Council Directive 92/43/EEC of 21 May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora (OJ EC L 206 p. 7), in the applicable valid version, shall also serve the purpose of protecting or restoring a favourable conservation status for

1. The priority habitat types

decalcified fixed dunes with *Empetrum nigrum* (brown dunes), fixed coastal dunes with herbaceous vegetation (grey dunes), coastal lagoons (beach lagoons);

2. The habitat types
sandbanks which are slightly covered by sea water all the time; (non-vegetated) mudflats and sandflats not covered by seawater at low tide; large, shallow inlets and bays (shallow-water zones and sea-grass meadows); reefs, *salicornia* and other annuals colonizing mud and sand; spartina swards (*Spartinion maritimae*); Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*); embryonic shifting dunes, shifting dunes along the shoreline with *Ammophila arenaria* ("white dunes"); dunes with *Hippophaë rhamnoides*; dunes with *Salix repens ssp. argentea* (*Salicion arenariae*); wooded dunes of the Atlantic, Continental and Boreal region; humid dune slacks; estuaries; oligotrophic to mesotrophic standing waters; and
3. The non-prioritary plant and animal species
seal, harbour porpoise, sea lamprey and fen orchid.

[2]The protection purpose pursuant to Sentence 1 shall apply to areas that, in the Act on the "Wadden Sea of Lower Saxony" National Park of 15 July 1999 (Lower Saxony's Law Gazette p. 164), are designated as core zones and transition zones in the national park, as well as to core zone I/1 pursuant to this Act and the areas referred to in Annex 3 to this Act, maps 34 and 35, as core zones or transition zones. [3]All persons may view the Act of 15 July 1999, at no charge, at the facilities of the lower nature conservation authorities in the territory of the national park and at the facilities of the national park's administration. [4]Where in a procedure pursuant to Article 4 (2) of Directive 92/43/EEC areas of the national park other than those specified in Sentence 2 are defined as areas of Community importance, such definition shall take precedence. [5]The Ministry of the Environment of Lower Saxony shall publicly announce what areas are of relevance under Sentence 4.

Section 3
Area of application

(1) [1]The boundaries of the national park are shown in the attached maps, which are part of this Act:
1. Map drawn to a scale of 1 : 100,000 (**Annex 2**),
2. Reduced-size German basic maps (Deutsche Grundkarten) drawn to a scale of 1 : 10,000 (**Annex 3**).
[2]Areas enclosed by the national park that are not assigned to any of the zones listed in Section 5 (1) are not part of the national park.
(2) On the seaward side and in the estuaries of the Ems, Weser and Elbe rivers, and in Jade Bay, the line connecting the points shown in Annex 2 and specified via geographic coordinates (GPS - World Geodetic System 84) shall be the standard for demarcation of the national park, except where Lower Saxony's state boundary, or a flow-guidance structure, passes through the Elbe and Weser river estuaries, between two coordinate points; in such cases, the national park's boundary shall be formed by the state boundary or by that side of the flow-guidance structure's base that faces away from the current.

(3) [1]The national park's landward boundaries are shown, as dotted lines, in Annexes 2 and 3. [2]In the boundary sections marked, in Annexes 2 and 3, by an interrupted dotted line, the boundary shall be defined by the mean high-tide line. [3]In the sections marked, in Annexes 2 and 3, by a red dotted line, the dike's seaward boundary (Section 4 (3) of Lower Saxony's Act on dikes) shall defined the park's boundary. [4]The map shall be the standard for determining the course of the boundaries shown, in Annexes 2 and 3, by a black, non-interrupted dotted line. [5]Where, pursuant to Sentence 3, the dike's seaward boundary forms the national park's boundary, the latter boundary shall change in keeping with permitted changes of the existing dike. [6]If necessary in such cases, the ministry responsible for nature conservation shall re-issue Annexes 2 and 3.

Section 4

Setting aside of areas for airfields and airstrips

(1) The state government shall be authorised to remove, by ordinance, areas on the East Frisian islands from the territory of the national park in order to make it possible to lengthen existing runways, if the necessary permits have been issued for such action – especially permits under air transport laws – and such lengthening is urgently required in order to fulfill requirements pursuant to Section 1 (2) No. 1 of the Ordinance on operation of aircraft (Betriebsordnung für Luftfahrtgerät) of 4 March 1970 (Federal Law Gazette I p. 262), last amended by Article 3 of the ordinance of 3 August 1998 (Federal Law Gazette I p. 2010, 2669).

(2) Where areas are removed from the territory of the national park, pursuant to Para.1, the maps pursuant to Section 3 (1) shall be suitably modified within the framework of the relevant ordinance.

Section 5

Division into zones

(1) [1]The national park shall be divided into three zones, as shown in the maps pursuant to Section 3 (1):

1. Core zone (Zone I) – red,
2. Transition zone (Zone II) – green,
3. Recreation zone (Zone III) – yellow.

[2]In the maps of Annexes 2 and 3, the various areas of Zone I are marked by numbers (Arabic numerals).

(2) Where not otherwise specified in Paragraphs 3 and 4, the maps specified in Section 3 (1) shall be the standard for determining the zones' boundaries.

(3) [1]The areas of the core zone are described in Annex 1. [2]The following shall apply for demarcation of core-zone areas:

1. Unchanging boundary points shall be determined by means of geographic coordinates.
2. The map specified in Section 3 (1) shall be the standard for determining the core-zone boundaries shown, via an unbroken line in the map, as permanent boundaries.
3. The course of the core-zone boundaries shown, via an interrupted line, in the map referred to in Section 3 (1), as changing boundaries, shall be described via the information contained in Annex 1 – and, at sea,

in connection with the relevant valid official sea chart. Where a core-zone boundary is formed by the outer side of a flat or a sand area, the zero line on the relevant sea chart shall be the standard; where the core-zone boundary is formed by a tidal channel (*Priel*), a navigation channel (*Balje*) or a natural or artificial passage (*Gat*), the sea chart's zero line on the side facing toward the core zone shall be the standard. Where the boundary is formed by buoys, a dune base or other locally identifiable natural or artificial landmarks, the locations of such landmarks shall be the standard.

(4) [1]The seaward boundary of the recreation zone shall be formed by the mean high-tide line, except where Annex 3 designates lower areas as recreation zones. [2]In such cases, the seaward boundary, marked with an interrupted line, shall be formed by the sea-chart's zero line; the side boundary shall be formed by the straight line between marking posts which, as specified in Annex 3, stand in each case on the mean high-tide line and above that line. [3]Otherwise, demarcation of lower areas of the recreation zone shall be in accordance with the description given in Annex 3.

Section 6

Actions prohibited in the core zone

(1) [1]In the core zone, all actions are prohibited that destroy, damage or change the national park or any of its components. [2]By way of derogation from Sentence 1, the actions specified in Arts. 7 to 11, and 16, and the actions specified in Annex 1, shall be permitted. [3]Sentence 2 shall not apply to the areas I/7, I/23, I/35, I/37, I/38, I/41, I/42 and I/45, where the actions destroy, damage or change the soil, its vegetation or any *Psammocorallia*.

(2) In the interest of preventing disturbances and hazards for the national park's protected assets, it shall be prohibited

1. to disturb the peace of the park's nature via noise or other means,
2. to disturb wild animals, or to seek out, photograph or film them in their nesting, breeding, dwelling and refuge areas,
3. to permit dogs to run unleashed, where such action does not occur in the framework of permitted hunting,
4. to light or feed fires in places other than designated places for fires,
5. to fly kites, model aircraft or other small aircraft, to launch balloons, or to operate remote-controlled vehicles outside of pathways, where such actions are not permitted by this Act or on the basis of this Act.

Section 7

Agriculture and grazing in the core zone

(1) [1]Except as provided in Sentence 2, no restrictions shall be placed on proper agricultural soil use on areas protected by a primary dike, summer dike or protective dune, including maintenance and renovation of pertinent facilities, grazing of horses on inhabited islands and erection of conventional-type pasture fences, livestock waterers and milking parlours. [2]It shall be prohibited

1. to grade areas, to change the profile of the land surface from that present upon the entry into force of this Act or to carry out excavations or land-filling,

2. to convert grassland areas to farmland,
3. to plow grassland for purposes of new seeding, and
4. to use plant pesticides.

(2) Proper agricultural soil use on areas not protected by a primary dike, summer dike or protective dunes, including maintenance and renovation of pertinent facilities and grazing of horses on the area's inhabited islands, shall be permitted in the manner and extent in which such use has been carried out to date.

(3) The Weser-Ems district government shall control management of state-owned areas not protected by a primary dike, summer dike or protective dunes, taking account of Section 2, via foreland-management measures, and in cooperation with the relevant affected dike association (*Deichverband*).

(4) [1]The national park's administration shall reach agreement, with the relevant island communities and demesne administrations, and with the participation of affected owners of haulage firms, regarding a grazing plan for the state-owned salt-meadow (*Heller*) areas on the islands of Baltrum, Juist and Spiekeroog. [2]The grazing plan shall regulate options for grazing, taking special account of the draught horses used for transport purposes. [3]The plan shall ensure that habitat types pursuant to Section 2 (3) in the national park that are affected by grazing are not significantly impaired and that avifauna are protected against significant impairments and disturbances. [4]The plan shall take account of the existing extent of grazing.

Section 8
Hunting in the core zone

(1) Hunting rights may be exercised in keeping with Lower Saxony's Hunting Act (*Niedersächsisches Jagdgesetz*), to the extent Paragraph 2 does not make other provisions.

(2) [1]Hunting of waterfowl shall be permitted only on inhabited islands and only with the consent of the national park's administration. [2]Such consent shall be granted separately for each island, for a period totalling up to ten days per year; the days on which hunting is permitted need not form a single, continuous hunting period. [3]Applications must be submitted in writing, by the holder of the lease to the relevant hunting district, no later than one week prior to the planned hunting date. [4]Consent for hunting shall be tied to the condition that hunting shall not significantly undermine the protection purpose of this Act. [5]No consent for hunting shall be given for official census days, in the framework of international censuses of water and wading birds, as announced by Lower Saxony's state office for ecology – state bird conservation station (*Niedersächsisches Landesamt für Ökologie – Staatliche Vogelschutzwarte*). [6]If a day for which permission for hunting has been granted is not used, due to inclement weather, consent for a substitute day shall be provided, upon application, subject to the provisions of sentences 3 to 5.

(3) The national park's administration may initiate measures for controlling populations of game species and other animal species, including waterfowl.

Section 9
Fishing in the core zone

(1) Commercial fishing for fish and shrimp, and commercial fishing with fixed nets, including use of mud sleds, shall be permitted in the core zone; this shall not apply to the areas I/8, I/10, I/18, I/24, I/28, I/30, I/32, I/33, I/34 and I/48.

(2) [1]Commercial mussel fishing, and establishment of mussel farms, shall be permitted, subject to the restrictions arising from sentences 2 and 3, in core-zone areas I/2, I/4, I/5, I/6, I/13, I/14, I/21, I/22, I/27, I/29, I/31, I/36, I/39 and I/40. [2]Collection of stocking mussels shall be permitted only in the framework of a management plan issued, and updated every five years, by the supreme fisheries authority, in cooperation with the supreme nature conservation authority, and in keeping with the protection purpose of this Act; this shall also apply to core zone area I/17, except where collection of stocking mussels is permitted in that area pursuant to Annex 1. [3]Mussels intended for human consumption may be collected from wild mussel beds only when they are continually covered by water in such beds.

(3) Fishing for sport and recreation, including digging by hand for worms in mud flats, shall be permitted in the core area, from specially marked paths and fishing areas.

(4) Co-fishing rights of inhabitants of the city of Langen, of the municipality of Nordholz and of the Land Wursten federation of municipalities (*Samtgemeinde*), in areas I/44 and I/45, and in the south of the eastern part of area I/47 – bounded to the west by the Neucappeler Tief area and bounded to the north by the Oxstedter Tief area – and as entered in the water register (*Wasserbuch*) for the Weserküste area, may be exercised to the extent that the areas can be travelled on foot.

Section 10

Other uses in the core zone

Operation of honeybee mating areas, on the islands, and removal of silt from designated areas, for medical purposes, shall be permitted.

Section 11

Entry into the core zone

The core zone may be entered only for the following purposes:

1. for engaging in uses permitted pursuant to Arts. 7 to 10,
2. for purposes of hiking over tidal flats ("*Wattwandern*"), hiking, cycling, horseback riding, carriage rides and for supply transports, on designated pathways and routes,
3. for use of public roads,
4. for temporary stays by crews of sport boats that have been grounded by low tide directly next to a navigation lane that crosses the core zone within the meaning of Section 2 (1) No. 1 of the German traffic regulations for navigable maritime waterways (*Seeschifffahrtsstraßen-Ordnung*), within a 50 meter radius around the boat,
5. for inspection of water vessels grounded by low tide, on designated locations near the harbour channel (*Hafentief*).

Section 12

Actions prohibited in the transition zone

(1) Prohibitions pursuant to Section 6 shall apply, mutatis mutandis, in the transition zone, except where other provisions follow from the following paragraphs.

(2) [1]Where the protection purpose permits, exemptions may be permitted, in individual cases, from Section 6 (1) Sentence 1 for

1. measures that result in damage to the vegetation cover,

2. the erection of vending facilities, booths, temporary structures, tents and beach baskets (*Strandkörbe*) and

3. the installation of advertising media, signs or inscriptions.

[2]Under conditions pursuant to Sentence 1, exemptions shall be permitted for

1. removal of sand or soil material for maintenance of coastal-protection structures, and

2. removal of sand for maintenance of beaches located in the recreational zone, or located on the East Frisian islands, outside of the national park.

(3) [1]The prohibition under Section 6 (2) No. 1 shall not apply to events for celebrating traditional customs. [2]Exemptions may be permitted, in individual cases, from the prohibition pursuant to Section 6 (2) No. 2, to an extent in keeping with the protection purpose.

Section 13

Uses permitted in the transition zone

(1) Arts. 7 to 10 shall apply mutatis mutandis, except where other provisions arise through the following paragraphs.

(2) Exemptions from restrictions pursuant to Section 7 (1) Sentence 2 Nos. 3 and 4 may be permitted, to an extent in keeping with the protection purpose.

(3) Restrictions pursuant to Section 8 on hunting waterfowl shall not apply.

(4) The provision established by Section 9 (2) shall apply, mutatis mutandis, throughout the entire area of the transition zone.

(5) Fishing for sport and recreation, including digging for worms in mud flats, shall be permitted throughout the entire transition zone, in keeping with the provisions of Section 14 (2).

(6) Inhabitants of municipalities whose territories are located fully or partly in the national park (local population), may

1. collect edible mushroom and berries and,

2. harvest cabbage for their own use, in the months of May and June, and between the Weser and Elbe rivers.

Section 14

Entry into the transition zone

(1) [1]Except for the purposes listed in Arts. 11, 12 and 13, persons may enter the transition zone only on foot, by wheelchair or by non-motorised vehicles. [2]Parking of mobile homes shall be prohibited. [3]Overnight stays shall be permitted only on sport boats anchored near harbours of the East Frisian islands, in designated locations, and must be limited to a total of one night. [4]In derogation of Sentence 1, driving or parking of motorised vehicles may be permitted, to an extent in keeping with the protection purpose.

(2) [1]During the period from 1 April to 31 July of each year (a period when birds breed and raise young), grassland areas, and associated tidal channels, located between the primary dike, the protective dune base facing the tidal flats or the seaward base of the Geest-area boundary, and the mean high-tide water line, may be entered only on designated areas, roads, pathways or routes. [2]This restriction shall not apply to exercise of uses permitted pursuant to Arts. 7, 8, 9 (1), (2) and (4) and Section 13 (6) No. 2. [3]Where the protection purpose permits, exemptions from the prohibition on entry set forth in Sentence 1 may be permitted.

(3) [1]Rights of entry may be restricted, via individual order, for certain areas that, following the entry into force of this Act, develop into a habitat pursuant to Section 2 (3) or into a biotope pursuant to Section 28 a (1) of Lower Saxony's Nature Conservation Act, or that have acquired a significantly greater importance with regard to species conservation pursuant to Section 2 (2) or (3), or if such a restriction is required to counter significant impairment of habitats of the priority types named in Section 2 (3) Sentence 1 No. 1. [2]Such restrictions shall be limited in duration to a period of no longer than five years. [3]Upon their expiration, restrictions may be extended once for a period of no longer than five years, if the reasons for the restriction are still extant.

Section 15
Recreation zone

(1) [1]The recreation zone may be used only for recreation, especially for such activities as walking, camping, swimming, sitting in beach baskets, horseback-riding, fishing, collection of mussels, kite-flying and sports activities. [2]Use of motorised vehicles, and erection of beach igloos, mobile changing cabins and toilets, and of similar mobile facilities, shall be permitted to the extent required to make uses permitted under Sentence 1 possible.

(2) In particular, it shall be prohibited

1. to erect camping tents or to set up caravans,
2. to hold noise-intensive events,
3. to drive beach buggies, or similar motorised recreational vehicles, on the beach, and
4. to erect structures, except as permitted under Paragraph 1 Sentence 2.

(3) Noise-intensive events, except for motor-sports events, may be permitted in individual cases, to an extent in keeping with the protection purpose.

(4) Removal and filling of sand, for purposes of beach maintenance, shall be permitted, to an extent in keeping with the protection purpose.

(5) Uses pursuant to Paragraph 1 Sentence 1 shall be restricted, via individual orders, where they can lead to destruction, or to significant or lasting impairment, of a biotope within the meaning of Article 20 c (1) of the Federal Nature Conservation Act and are not required for predominating reasons of the public interest.

Section 16
Exceptions

[1]The prohibitions under this Act shall not apply to

1. Measures serving the purpose of fulfilling public tasks

a) of the national park's administration,

b) for collection of waste and for cleaning of the beach,

c) of the water-resources administration, except for new construction of dikes,

d) of the fisheries administration and the hunting administration,

e) for preventing hazards and dangers, for disaster management, of explosive ordnance removal services and for accident response, including sea rescue,

f) of Lower Saxony's state office for soil research (Niedersächsisches Landesamt für Bodenforschung),

g) of the Federal Authority for Maritime Shipping and Hydrography (BSH) (sea surveying),

h) of the German Federal Waterways Administration (WSV), for fulfillment of the tasks with which it is legally charged, especially tasks with regard to federally owned structures of the maritime navigation and electrical infrastructure, and to the island-protection structures to be maintained by the Federal Government pursuant to Section 8 (5) of the Federal Waterway Act (Bundeswasserstraßengesetz), with the exception of widening of waterways,

2. Maintenance measures carried out by organisations responsible for dike maintenance (coastal protection), with the exception of new dike construction,

3. Measures for maintenance and service

a) in existing harbour access ways, including the pertinent navigation lanes,

b) for existing roads and pathways, including the pertinent peripheral areas in keeping with Section 2 (2) of Lower Saxony's Road Act (Niedersächsisches Straßengesetz),

c) on existing summer dikes,

d) in dike forelands, where such measures are required for dike safety pursuant to Arts. 21 and 22 of Lower Saxony's Dike Act (Niedersächsisches Deichgesetz),

4. The operation, maintenance and servicing

a) of pipelines, cables and transport lines for supply of energy and water and for wastewater removal, including pertinent facilities,

b) postal and telecommunications facilities,

c) existing railway and air-transport infrastructure facilities,

d) existing facilities for production and supply of drinking water,

5. The use and maintenance of existing, permitted structures and facilities, and their pertinent open areas, in keeping with the relevant applicable permits, and
6. The use and maintenance of the existing tenting area in the Süderdünen bounded area (Gemarkung) on the island of Spiekeroog.
[2]Where measures pursuant to Sentence 1 Nos. 1 and 2, either individually or in conjunction with other measures, could significantly impair protected assets pursuant to Section 2 (2) and (3), they shall be permitted only under the conditions set forth in Article 19 c of the Federal Nature Conservation Act. [3]Dumping of sand, silt and dredged or excavated material, except for shifting of material in the immediate vicinity of navigation lanes and tidal inlets, shall not be exempted. [4]Collection of waste, and beach cleaning pursuant to Sentence 1 No. 1 letter b, shall be permitted in the core zone only at certain times, as defined by the competent authority, taking account of the relevant protection purpose and by agreement with the national park's administration.

Section 17
Exemptions

[1]Exemptions from the prohibitions under this Act may be granted, upon application, if
1. Application of the provisions, in individual cases,
a) would lead to unintended hardship, and departure from the provisions can be reconciled with the needs of nature conservation and landscape management, or
b) would lead to an unintended impairment of natural assets and the landscape
or
2. predominating reasons of the public interest necessitate the exemption.
[2]Where an application for exemption affects projects or measures that, either individually or in conjunction with other projects or measures, could significantly impair protected assets pursuant to Section 2 (2) and (3), the exemption may be issued only under the conditions set forth in Article 19 c of the Federal Nature Conservation Act.

Section 18
Designation of pathways and other parts of the area

Where, pursuant to Arts. 9 to 11, and 14, and to Annex 1, certain actions are permitted only on designated pathways, routes, areas or other sections of the main area, decisions on pertinent designation shall take account of the protection purpose.

Section 19
Compensation and offsets

For usage restrictions resulting from prohibitions under this Act, or from measures carried out on the basis of this Act, Arts. 50 to 52 of Lower Saxony's Nature Conservation Act shall apply mutatis mutandis.

Section 20

Provision of information

(1) [1]The national park's administration shall provision information and carry out educational activities, to the extent reconcilable with the protection purpose pursuant to Section 2. [2]To this end, it shall maintain suitable facilities in the national park territory or shall cooperate in maintaining such facilities.

(2) [1]Informational and educational activities should have the function of helping to achieve the national park's protection purpose and to enhance public awareness of ecological relationships. [2]Such activities should call attention to the possibilities for experiencing nature and engaging in recreation that the national park offers, and it should communicate the national park's aims to the public. [3]Such activities should also explain work carried out in the national park, including scientific studies and research projects.

(3) [1]In its informational and educational activities, the national park's administration should cooperate with relevant municipalities and associations, where such organizations carry out public relations work with regard to the national park, and should do so especially via jointly operated or Land-(state-)subsidised facilities. [2]The national park's administration may arrange for suitable persons to take part in informational and educational activities.

Section 21

Research

(1) [1]The national park's administration shall carry out scientific studies of its own and coordinate external research projects. [2]Scientific monitoring and research in the national park shall be subject to the consent of the national park's administration; such consent shall be provided where such monitoring and research have the aims of

1. Studying the organisation, development and interrelationships of natural and semi-natural communities,
2. Gaining findings relevant to nature conservation,
3. Yielding findings about human impacts or findings relevant to supra-regional monitoring of environmental changes, or
4. Supporting the national park's administration in fulfillment of its tasks

and are reconcilable with the protection purpose pursuant to Section 2.

(2) Relevant consent may be provided subject to the condition that findings from monitoring and research be made available to the national park's administration.

Section 22

Management and development measures

(1) [1]The national park's administration may order certain measures for management or development of the national park. [2]Section 29 (2), (3) and (5) of Lower Saxony's Nature Conservation Act shall apply mutatis mutandis.

(2) [1]Associations and other legal entities may be given responsibility, subject to their own consent and subject to revocation, for

1. Management, care and development of parts of the national park, and
2. Certain tasks of species conservation

if they provide guarantees that such tasks will be properly fulfilled. [2]Relevant decisions shall be taken by the national park's administration. [3]Sovereign powers may not be transferred.

Section 23

Administration

Administration of the national park, including the park's areas located in the Lüneburg administrative district, shall be carried out by the district government of Weser-Ems, via the "Wadden Sea of Lower Saxony" ("Niedersächsisches Wattenmeer") administration, located in Wilhelmshaven, except as this Act specifies that other authorities shall be responsible.

Section 24

Responsibilities

(1) In addition to having responsibility for tasks assigned to it in Arts. 7, 8 and 20 to 22, the national park's administration shall also be responsible for

1. Preparing concepts for conservation, development and management measures,
2. Coordinating the work of lower nature conservation authorities active in the national park's territory, as well as of the agencies and associations entrusted with, or otherwise active in, tasks of management, support and development in the national park's territory,
3. Permitting exceptions, and granting exemptions, in the transition zone and recreation zone, except where a lower nature conservation authority is responsible pursuant to Paragraph 2, and granting exemptions in the core zone,
4. Designating pathways, routes, areas and other sections of the general area, for certain actions pursuant to Section 18, and, in the territory for which a lower nature conservation authority is responsible, making such designations with the consent of that authority,
5. Determining the condition of the protected assets specified in Section 2 (3), for preparation of reporting to the European Commission,
6. Exercising rights of preemption on behalf of the Land (state),
7. Restricting rights of entry pursuant to Section 14 (3), except where a lower nature conservation authority is responsible pursuant to Paragraph 2,
8. Restricting uses pursuant to Section 15 (5), except where a lower nature conservation authority is responsible pursuant to Paragraph 2, and
9. Carrying out other tasks, including tasks assigned to lower nature conservation authorities by Section 55 (2) Sentences 1 and 2 of Lower Saxony's Nature Conservation Act, except where this Act makes other provisions.

(2) [1]The competent lower nature conservation authorities shall be responsible for

1. Permitting exceptions, and granting of exemptions, with regard to areas in the recreation zone and transition zone that lie within their areas of responsibility,

2. Restricting rights of entry pursuant to Section 14 (3) with regard to areas that lie within their areas of responsibility,

3. Restricting uses pursuant to Section 15 (5) with regard to areas that lie within their areas of responsibility,

4. Coordinating with dike associations (Deichverbände) regarding removal of flotsam in dike forelands, and

5. Taking decisions on projects involving soil removal, with regard to areas in the recreation zone and transition zone that lie within their areas of responsibility.

[2]Exceptions, exemptions and permits and orders pursuant to Sentence 1 shall be granted/issued by agreement with the municipality on whose territory the action or measure is to take place.

(3) Where a project requires several exceptions or exemptions pursuant to Paragraph 1 and Paragraph 2, then the national park's administration shall decide upon the granting of such exceptions or exemptions, by agreement with the relevant lower nature conservation authority.

(4) [1]The national park's administration shall be responsible for measures pursuant to Section 63 of Lower Saxony's Nature Conservation in the core zone and in non-municipal sections of the transition zone and recreation zone located below the mean high-tide water line, including such areas located within the Lüneburg administrative district. [2]Otherwise, the relevant lower nature conservation authorities shall be competent.

(5) The national park's administration may form a landscape ranger service, consisting of suitable persons, to monitor the territory of the national park and ensure that species are protected.

Section 25

Regional interests

In their decisions pursuant to this Act, the competent authorities shall take account of the local population's interests in safeguarding and developing their living and working conditions, as well as the interests of regional development, commerce and business and tourism, to an extent in keeping with the protection purpose.

Section 26

State-owned lands

The authorities that, in the framework of their competencies, take decisions regarding use of Land-(state-)owned lands and granting of usage rights, shall in this regard take special account of the Act's protection purpose.

Section 27

National park advisory board

(1) [1]An advisory board shall advise the national park's administration; the advisory board shall support the national park's administration in its task of fulfilling the protection purpose while taking other public interests into account. [2]The advisory board's members shall include

1. Two members for the lower nature conservation authorities in whose scope of responsibility parts of the national park lie,
2. Three members for relevant municipalities,
3. Two members for the nature conservation associations recognised pursuant to Article 29 of the Federal Nature Conservation Act,
4. One member each for chambres of commerce, for chambres of agriculture whose spatial areas cover parts of the national park, for dike associations, tourist associations and the state athletic federation (Landessportbund),
5. Two members representing Lower Saxony's universities' scientific departments for nature conservation / landscape management and biology,
6. One member from the Federal Ministry responsible for nature conservation, and
7. One member for the Weser-Ems state fisheries federation (Landesfischereiverband).

(2) [1]The members of the advisory board shall be appointed by the supreme nature conservation authority for a period of five years. [2]The members pursuant to Paragraph 1 Sentence 2 Nos. 1, 3 and 4 shall be appointed by the authorities, associations and bodies that send them, while the members pursuant to Paragraph 1 Sentence 2 No. 2 shall be appointed by the working group of Lower Saxony's municipal leading associations (Arbeitsgemeinschaft der kommunalen Spitzenverbände Niedersachsens) and the members pursuant to Paragraph 1 Sentence 2 No. 5 shall be appointed by the relevant departments. [3]Section 12 (1) of Lower Saxony's equal rights act (Niedersächsisches Gleichberechtigungsgesetz) shall apply mutatis mutandis to appointments.

(3) If, in cases in which several associations and organisations have joint rights of appointment (Paragraph 1 Sentence 2 Nos. 1, 3, 4 and 5), the participating associations and organisations cannot reach agreement within a period of two months following the request for an appointment, then the supreme nature conservation authority shall take the relevant decision.

(4) [1]The national park's administration shall hear the advisory board

1. In connection with preparation of concepts for conservation, development and management measures,
2. In connection with research projects (to the extent the national park's administration is involved in them),
3. In connection with preparation of informational material about the national park or parts thereof,
4. In connection with formation of a landscape ranger service, and
5. In connection with questions of national and international cooperation (research, excursions, etc.).

[2]The advisory board may make proposals, regarding measures in the national park, to which the national park's administration must respond in the framework of its competencies.

(5) The advisory board's regular course of business, including representation of advisory board members, shall be defined by rules of procedure issued by the supreme nature conservation authority.

Section 28
Administrative offences

(1) Anyone who, intentionally or negligently, and without such action's having been permitted by this Act or on the basis of this Act,

1. in contravention of Section 6 (1), undertakes an action, in the core zone, that destroys, damages or changes the zone or its individual components,
2. in contravention of Section 6 (2) undertakes a disturbing or dangerous action in the core zone,
3. enters the core zone for purposes other than those permitted by Section 11,
4. in contravention of Section 12 (1) in conjunction with Section 6 (1), undertakes an action, in the core zone, that destroys, damages or changes that zone or its individual components,
5. in contravention of Section 12 (1) in conjunction with Section 6 (2), undertakes a disturbing or dangerous action in the transition zone,
6. enters the transition in violation of Section 14,
7. in the recreation zone, violates the prohibitions of Section 15 (2) or a restriction pursuant to Section 15 (5),

shall be deemed to have committed an administrative offense.

(2) An administrative offence pursuant to Paragraph 1 Nos. 2, 3 and 5 to 7 shall be punishable with a fine of up to 30,000 euros, while an administrative offence pursuant to Paragraph 1 Nos. 1 and 4 shall be punishable with a fine of up to 55,000 euros.

(3) Section 66 of Lower Saxony's Nature Conservation Act shall apply mutatis mutandis to administrative offences pursuant to this Act.

Section 29
Application of Lower Saxony's Nature Conservation Act

With the exception of Arts. 5, 6, 7 (2) Sentence 2, Arts. 28 a, 28 b and 55 (2) Sentences 1 and 2, the provisions of Lower Saxony's Nature Conservation Act shall apply, except where this Act makes other provisions.

Section 30
Transitional provisions

(1) Pathways that, upon the entry into force of this Act, become parts of the core zone for the first time, may be used in the existing manner for one year following the entry into force of this Act.

(2) [1]The management plan of 30 November 1998 issued by the supreme fisheries authority, in cooperation with the supreme nature conservation authority, shall be considered the management plan within the meaning of Section 9 (2) Sentence 2. [2]It shall be updated by 1 December 2003.

(3) The national park advisory board pursuant to Section 27 shall not be appointed until after the end of the current advisory board's term of office.
(4) Until 31 December 2001, fines pursuant to Section 28 shall be fixed in deutschmarks, in keeping with the standard conversion rate.

Article 2
Changes and suspension of provisions

Section 1
Amendment of Lower Saxony's Nature Conservation Act

Lower Saxony's Nature Conservation Act, in the version of 11 April 1994 (Lower Saxony Law Gazette (Nds. GVBl.) p. 155), last amended by Article 10 of the Act of 15 December 2000 (Lower Saxony Law Gazette (Nds. GVBl.) p. 378), shall be amended as follows:
1. Section 25 shall be deleted.
2. In Section 29 (5), the words "and national parks" ("und Nationalparke") shall be deleted.
3. In Section 52 (1) Sentence 1, the words "national parks" ("Nationalparks"), and the reference "Section 25 (2)", shall be deleted.
4. Section 53 (1) shall be amended as follows:
a) The existing Sentence 1 shall become the only sentence.
b) Sentence 2 shall be deleted.
5. Section 55 (3) shall be amended as follows:
a) The existing Sentence 1 shall become the only sentence.
b) Sentence 2 shall be deleted.
6. In Section 64 No. 4, the reference "or Section 25 (2)", the words "or national park" ("oder Nationalpark") and, following the words "the nature conservation area" ("das Naturschutzgebiet"), the comma and the words "the national park" ("den Nationalpark") shall be deleted, and the word "their" ("ihrer") shall be replaced by the word "its" ("seiner").

Section 2
Suspension of ordinances on nature conservation areas and a landscape-conservation area

(1) The Ordinance on the "Dollart" nature conservation area of 17 September 1980 (Official Gazette (Amtsblatt) for the Weser-Ems administrative district p. 998), and the Ordinance on the "Duhner Heide/Wittsand" nature conservation area of 18 October 1990 (Official Gazette (Amtsblatt) for the Lüneburg administrative district, p. 207; 1994 p. 122) shall be suspended.
(2) The Ordinance on the "Eichenkrattwälder bei Berensch" nature conservation area of 9 December 1982 (Official Gazette (Amtsblatt) for the Lüneburg administrative district, p. 282), the Ordinance for conservation of landscape sections in the Land Hadeln district (Wernerwald and beach) of 2 November 1938 (Official Gazette (Amtsblatt) of the Stade government, p. 148), amended by ordinance of the

Cuxhaven rural district of 21 May 1986 (Official Gazette (Amtsblatt) for the Lüneburg administrative district, p. 198), the Ordinances for conservation of landscape sections in the municipality Berensch-Arensch (Land Hadeln district) of 23 March 1960 (Official Gazette (Amtsblatt) for the Stade administrative district, p. 35) and of 23 September 1960 (Official Gazette (Amtsblatt) for the Stade administrative district, p. 128) and the First supplementary ordinance (Nachtragsverordnung) for protection of natural monuments in the Land Hadeln district of 30 June 1938 (Official Gazette (Amtsblatt) of the Stade government, p. 119), shall be suspended to the extent they comprise areas that, upon the entry into force of this Act, become part of the "Wadden Sea of Lower Saxony" National Park.

Article 3

Entry into force

(1) This Act shall enter into force on the day after it is promulgated.

(2) At the same time, the Act on the "Wadden Sea of Lower Saxony" National Park of 15 July 1999 (Lower Saxony's Law Gazette (Nds. GVBl.) p. 164) shall expire.

Annex 1

Area of core zone No.	Designation, extent	Special protection purpose	Permitted uses in addition to stipulations in Sections 6 to 11 and 16
I/1	Dollart Outer dike and tidal flat (Watt) areas to the state boundary south of the line heading west and connecting the base of the Geisesteert flow-control structure with the turning point of the state boundary to the south	Typical ecosystem of a brackish bay mud flat and bordering outer-dike areas, with characteristic plants and animals, and with special importance as a resting, breeding and feeding area for sea, wading and water birds, and with a special diversity of geological and cultural features	
I/2	Rysumer Nacken Outer dike and coastal tidal flats between the Upleward recreation zone and the outer boundary of the national park west of the Rysumer Hammrich area Manslagter Nacken Outer dike and coastal tidal flats between the monument dike and the Altendeich area	Important breeding, resting and feeding area for wading and water birds, important habitat of characteristic animal and plant species and communities, and typical ecosystem with features including tidal mud flats, sandbanks and lumachelles and dike foreland	
I/3	Greetsieler Nacken Outer dike and coastal tidal flats between the Ley navigation channel and Pilsum	Important breeding, resting and feeding area for wading and water birds, important habitat of characteristic animal and plant species and communities, and typical ecosystem with features including tidal mud flats, sandbanks and dike foreland	
I/4	Leybucht	Important resting and feeding area for wading and water birds,	Operation of the oil rig and transport pipeline

	Outer dike and coastal bay mud flats south of the Norddeich navigation channel through the tidal flat area, to the former radio station of Norddeich	important habitat for characteristic animal and plant species and communities, and typical ecosystem with sandbanks, mud flats and dike foreland	
I/5	Leybucht Sände Wadden Sea areas of Hamburger Sand, Kopersand, Mittelsand, Itzendorfplate and Branderplate south of the Memmert Wadden Sea navigation channel and north of Ley; Greetsieler Legde, Bantsbalje, Slapersbucht and Norddeich navigation channel through the tidal flat area to Busetief	Important section of seal habitat, important resting and feeding area for wading and water birds, important habitat for characteristic animal and plant species and communities, and typical ecosystem with sandbanks, island formation and mud flats	
I/6	Randzel and Lütje Hörn Sands south of the Borkum Wadden Sea navigation channel, and not including the Boesgatje area	Important section of seal habitat, important resting and feeding area for wading and water birds, important habitat for characteristic animal and plant species and communities, and typical ecosystem with sandbanks, island formation and mud flats	
I/7	Randzel eelgrass communities Area, bounded by coordinates, south-east of the "blind" Randzelgat area	Important eelgrass communities	
I/8	Borkum – Ost (east) Waterdelle/Muschelfeld area, east dunes and island salt marshes and dike foreland, salt meadows, embryonic dunes, beach and island tidal flats north of the Borkum Wadden Sea navigation channel, between a coordinate-defined line and the Ostplate area, but not including the northern foreshore area and a connecting beach strip 50 m wide, above the mean high-tide water line, to the Hooge Hörn area	Important habitat of characteristic plant and animal species and communities, and typical ecosystem, with coastal dunes, wet dune slacks, fens / marshes; important breeding area for harriers, important section of seal habitat, important breeding, resting and feeding area for water, wading and meadow birds	Collection of edible mushrooms and berries by the local population, for its own consumption, ice-skating by the local population, on Tüskendörsee lake, except in the particularly sensitive shore areas as defined by the national park's administration; collection of mussels and capture of grey mullet (*Mugil chelo*) in tidal channels, by the local population, for its own consumption
I/9	Borkum - Nordstrand Primary dune area north of the bases of the Kobbe and Oldmanns-Olde dunes, to 50 m in front of the mean high-tide water line	Important habitat for characteristic plant and animal species and communities; typical ecosystem of embryonic dunes	Entry on foot, outside of designated pathways, in the period from 16 July to 1 March of each year
I/10	Borkum - Greune Stee and Ronde Plate Dunes, salt meadows and tidal flats in the southern island area, and bounded by the "Süd" and "Wolde" dunes, railway embankment, harbour and south beach and salt meadows, north of the railway embankment from "Ostdeich" to "Reededeich"	Important breeding, resting and feeding area for water and wading birds, important breeding area for harriers, important habitat of characteristic animal and plant species and communities, and typical ecosystem with features including coastal dunes, wet dune slacks, fens / marshes, dike foreland and salt meadows,	Collection of edible mushrooms and berries, and recreational fishing, with handheld nets, by the local population, for its own consumption, except on salt meadows north of the railway embankment

		coastal tidal flats and sandbanks	
I/11	Hohes Riff Sands and tidal flat areas west of Borkum	Important section of seal habitat, important breeding area for wading birds, characteristic ecosystem with features including sandbanks, coastal tidal flats	
1/12	Borkum Riff Wadden Sea and coastal sea north of Borkum, the Kachelotplate area and Juist, to traffic-separation area	Specific ecosystem with gravelly to rocky bottoms, and, especially in southern sub-section, important resting and feeding area for divers, sea ducks and sandwich terns	Skin diving
1/13	Kachelotplate/Memmert Island tidal flats and uninhabited sand islands, bounded by the "Haaksgat" navigation channel, the Juister Balje area, the Nordland navigation channel and the Memmertbalje and Osterems areas	Important habitat for seals (including grey seals), important breeding, resting and feeding area for water and wading birds, important habitat for characteristic plant and animal species and communities, and typical ecosystem with features including sand beaches, island dunes; area with geologically important land forms (island formation)	Access to island of Memmert by permission of authorities
I/14	Juist – western section and Schillplate area Dunes, salt meadows and island tidal flats east of northern "Haaksgat" navigation channel, and north of the Juister Balje area	Important section of seal habitat, Important breeding, resting and feeding area for wading and water birds, important habitat of characteristic animal and plant species and communities, and typical ecosystem with features including coastal dunes, wet dune slacks, still waters, dike foreland, island tidal flats, sandbanks and salt meadows with large tidal-channel systems	Collection of edible mushrooms and berries and mussels by the local population, for its own consumption, ice-skating and ice-sailing by the local population on Hammersee lake; landing of boats, and entry on foot, in a designated area at the rock fill at the northern edge of the Juister Balje area, south of the pathway to the rescue shelter, and including the access to the walkway for crews of boats located on Juist or Norderney
I/15	Juist – Mitte (central area) Salt meadows between the community of Juist and the airfield	Salt-meadow area with tidal-channel systems, important breeding, resting and feeding area for wading and water birds, important habitat for characteristic plant and animal species and communities; typical ecosystem	
I/16	Juist – eastern section Beach and island tidal flats, Kalfamer area, including Ostende area, to Kalfamergat area	Important breeding, resting and feeding area for wading and water birds, important habitat of characteristic animal and plant species and communities, and typical ecosystem with features including coastal dunes, wet dune slacks, coastal lagoons, island tidal flats and sandbanks	
I/17	Norderney South beach polders, dike foreland, salt meadows, dunes, island tidal flats and intertidal mud flats between Norderney town,	Important breeding, resting and feeding area for wading and water birds, important breeding area for harriers, important habitat of characteristic animal and plant	Collection of edible mushrooms and berries by the local population, for its own consumption; stocking-mussel fishing north of the Norderney

	water works and the Wichter Ee area north of the Norderney Wadden Sea channel	species and communities, and typical ecosystem with features including sandy beaches, coastal dunes, wet dune slacks, fens / marshes, poorly drained water areas, dike foreland and salt meadows, island tidal flats and sandbanks; area with geologically important land forms (island formation)	Wadden Sea navigation channel, to a line connecting the points 7° 14' 36" E / 53° 41' 41" N and 7° 16' 26" E / 53° 41' 42" N, as well as in the sub-section bounded by the Norderney Wadden Sea navigation channel and the polygon drawn with the following co-ordinates: 7° 19' 45" E / 53° 42' 13" N, 7° 19' 31" E / 53° 42' 20" N, 7° 19' 29" E / 53° 42' 29" N, 7° 20' 29" E / 53° 42' 42" N.
I/18	Außendeich (outer dike) Dike foreland, including offshore reclamation fields (Lahnungsfelder) between the Finkenheller and Dornumersiel areas, but not including the Münster summer polder	Important breeding, resting and feeding area for wading and water birds, important habitat for characteristic animal and plant species and communities, and typical ecosystem with features coastal tidal flats and dike foreland	
I/19	Baltrum - east Parts of the central island dune area, with embryonic dunes north of the access path for emergency response	Important breeding, resting and feeding area for wading and water birds, important habitat of characteristic animal and plant species and communities, and typical ecosystem with features including coastal dunes and wet dune slacks	Collection of edible mushrooms and berries by the local population, for its own consumption; entry on foot, outside of designated pathways, from 16 July to 1 March of each year
I/20	Baltrum - Osterhook Salt meadows south of the access path for emergency response, Ostplate area and eastern Baltrum island tidal flats between the Accumer Ee and Baltrum Wadden Sea navigation channel	Important breeding, resting and feeding area for wading and water birds, important habitat of characteristic animal and plant species and communities, and typical ecosystem with features including salt meadows and island tidal flats	Collection of edible mushrooms and berries and mussels by the local population, for its own consumption, ice-skating by the local population, on the water areas west of the "Ost" (east) closure dike (Abschlussdeich), use of the volleyball courts of NTB Heim, for sports events, to the existing extent
I/21	Dornumer Nacken Intertidal mud flats (Plate) between the Baltrum Wadden Sea navigation channel and the Accumersieler Balje area	Important section of seal habitat, important resting and feeding area for water and wading birds	
I/22	Neiderplate Neiderplate area, west Damsumer Sand andWesterburer Watt areas, and dike foreland, including fronting reclamation fields (Lahnungsfelder) from Westeraccumersiel to Höhe Oldendorf	Important resting and feeding area for wading and water birds, typical ecosystem with features including coastal tidal flats and dike foreland	
I/23	Hungatplate Near-coastal section of the	Important eelgrass communities	

	Hungatplate area 100 m east of the navigation channel to Bensersiel and in front of the reclamation fields (Lahnungsfelder)		
I/24	Langeoog - Flinthörn Dunes, salt meadows and tidal flat bay	Important breeding, resting and feeding area for wading and water birds, important habitat for characteristic animal and plant species and communities, and typical ecosystem with features including sandy beaches, coastal dunes, dike foreland; area with geologically important land forms (island formation)	Collection of edible mushrooms and berries and mussels by the local population, for its own consumption
I/25	Langeoog – Südost (south-east) Osterhook, dunes and salt meadows; Langeoog island tidal flats to Langeoog Wadden Sea navigation channel	Important section of seal habitat, important breeding, resting, feeding and moulting area for wading and water birds, important habitat for characteristic plant and animal species and communities, and typical ecosystem with features including coastal dunes, wet dune slacks, still waters, salt meadows and dike foreland and island tidal flats	Collection of edible mushrooms, berries and mussels, and capture of grey mullet (*Mugil chelo*) in tidal channels, by the local population, for its own consumption
I/26	Langeoog - Nordost North beach, as of the Meierei Ostende access, including the fronting tidal flats and the Süder riff, from the dune base to the Otzumer Balje/Hullbalje navigation channel	Important section of seal habitat, important breeding, resting and feeding area for wading and water birds, typical ecosystem, with features including embryonic dunes and sandbanks; area with geologically important land forms (island formation)	Entry on foot, outside of pathways, in the period from 16 July to 1 March of each year
I/27	Janssand, Roggsand and Stüversplate Tidal flats between the Stüverslegde, Hullbalje, Schillbalje and Baklegde navigation channels and the Neuharlingersiel navigation channel	Important section of seal habitat, typical ecosystem with features including sandbanks, coastal tidal flats; area with geologically important land forms	
I/28	Spiekeroog – Westergroen and Ostergroen areas Western and central sections, with dunes and salt meadows between the former railway line and Spiekeroog town, but not including the campground east of the line at the rescue coordination post; and the salt meadows of Südergroen (eastern section) and Ostergroen	Important breeding, resting and feeding area for wading and water birds, important habitat for plant and animal species and communities, and typical ecosystem	Collection of edible mushrooms and berries by the local population, for its own consumption
I/29	Spiekeroog - Ostplate Spiekeroog island tidal flats, Swinnplate and Bakenplate areas, to the Alte Harle / Muschelbalje navigation channel	Important breeding, resting and feeding area for wading and water birds, important habitat for characteristic animal and plant species and communities, and typical ecosystem with features including coastal dunes, wet dune slacks, coastal tidal flats, dike	Collection of mussels and capture of grey mullet (*Mugil chelo*) in tidal channels, by the local population, for its own consumption; movement of heavy transports on the Deichtor line, to the old pier

		foreland, sandbanks, sandy beaches; area with geologically important land forms (island formation); important section of seal habitat	at the Hermann Lietz school (edge of tidal flats)
I/30	Schwerinsaußengroden area Salt marshes, including fronting reclamation fields (Lahnungsfelder) and tidal flats between the Neuharlingersiel and Harlesiel areas	Important breeding, resting and feeding area for wading and water birds, important habitat for characteristic animal and plant species and communities, and typical ecosystem with features including coastal tidal flats, dike foreland	
I/31	Elisabethaußengroden and tidal flats Outer salt marshes and eastern section of Harlesieler tidal flats; Langer Jan, Hoher Rücken, Südersand and Neues Brack areas, between the Carolinensieler Balje and Telegraphenbalje areas, the Wangerooger Wadden Sea navigation channel, the Minsener Balje area und the Minsener Oog navigation channel	Important section of seal habitat, important breeding, resting and feeding area for wading and water birds, important habitat for characteristic animal and plant species and communities, and typical ecosystem with features including sandy beaches, dike foreland, coastal tidal flats	
I/32	Wangerooge - West Westinnengroden and Westaußengroden salt marshes, Salinenbucht and western section of the Mittelaußengroden salt marsh	Important breeding, resting and feeding area for wading and water birds, important habitat for characteristic animal and plant species and communities, and typical ecosystem with features including coastal dunes, salt marshes, salt meadows and island tidal flats	Collection of edible mushrooms and berries by the local population, for its own consumption
I/33	Wangerooge - Ost Sections of the Ostinnengroden salt marsh, dune ridge east of the third dune overpass beginning at Café Neudeich, and salt meadows and tidal flats between the Georgspad and Blauer Balje areas	Important breeding, resting and feeding area for wading and water birds, important habitat for characteristic animal and plant species and communities, and typical ecosystem with features including sandy beaches, coastal dunes, salt meadows and island tidal flats	Landing of boats, and entry on foot, by crews of sport boats, in a special area designated with special account for breeding biotope of little terns, and located between the beach marker buoy (Strandbake) and the old pier, and including the access to the island loop pathway
I/34	Minsener Oog From the outer boundary of the national park to the Minsener Oog navigation channel, and to the Minsener Balje and Blauer Balje areas	Important breeding, resting and feeding area for wading and water birds, typical ecosystems, with features including dry sands and coastal tidal flats	
I/35	Crildumer Siel Dike foreland and tidal flat (Watt) areas to 50 m in front of the sea-chart zero line, between the Crildumer Siel dike overpass and the Wangerland bucket elevator,	Feeding area for wading and water birds, eelgrass communities; habitat for characteristic animal and plant species and communities, especially *Psammocorallia* communities	Swimming (by visitors) at the Hooksiel swimming beach

	as well as the the channel area between the sea-chart zero line and the outer boundary of the national park to the south, in the direction of the Hooksieler Hafentief (harbour channel)		
I/36	Jadebusen Petersaußengroden, Cäcilienaußengroden, Sander Watt and Bordumer Sand areas, north of the Dangaster Außentief (tidal inlet); Nordender Außengroden, Dangaster Außengroden, Kronshörne, Schweinsrücken, Arngastsand, western Würdelehersand and Vareler Watt, between Leitdamm, Vareler navigation channel (Fahrwasser) and Vareler Tief (channel); Nordschweiburger Groden, Neuer Groden, Neuwapeler Außengroden, Südender Außengroden, eastern Würdeleher Sand and Schweiburger Watt (tidal flats) between Vareler Tief (channel) and Schweiburger Tief; Augustaußengroden, Kleihörne and Sehestedt Außendeichsmoor (floating peat bog), Seefelder and Stollhammer Watt (tidal flats) areas, north of Schweiburger Tief (channel), with the exception of the area of core zone I/38	Important section of seal habitat, important breeding, resting and feeding area for wading and water birds, important habitat for characteristic animal and plant species and communities, and typical ecosystem with features including bay tidal flats, dike foreland, floating peat bog; area with geologically important land forms (tidal channel system, floating peat bog)	
I/37	Vareler Rinne From the outer boundary of the national park to the level of the Arngast lighthouse, between the Schweinsrücken sea-chart zero line to the west and the Jappensand sea-chart zero line to the east	Habitat for characteristic animal and plant species and communities, especially *Psammocorallia* communities	
I/38	Seefelder Watt Near-coastal tidal flats off the Augustaußengroden salt marshes	Important eelgrass community	
I/39	Hoher Weg Langwarder Außendeichsgroden (outer dike salt marsh); landing area off the Feldhauser Groden salt marsh, Hohe-Weg-Watt (tidal flats), not including the Turmloch, Mellum, Robbenplate, Mellumriffe and Mellumplate areas, between the Tossens sewage treatment plant and the Sengwarder Balje area, the outer boundaries of the national park and the	Important section of seal habitat, important breeding, resting and feeding area for wading and water birds; important habitat for characteristic animal and plant species and communities, and typical ecosystem with features including sandbanks, coastal dunes, coastal tidal flats, dike foreland; area with geologically important land forms (island formation)	Access to island of Mellum by permission of authorities

	Fedderwarder Priel (tidal channel)		
I/40	Große Plate west of the Weser River Platen (intertidal mud flats) from the outer boundary of the national park – from the Langlütjen Oberfeuer area – to Suezpriel, in a westerly direction	Important section of seal habitat, important resting and feeding area for wading and water birds, important habitat for characteristic animal and plant species and communities, and typical ecosystem	
I/41	Burhaver Plate Intertidal mud flats west of the area of core zone I/40	Important eelgrass community	
I/42	Waddenser Plate Tidal flats off the Waddenser outer dike	Important eelgrass community	
I/43	Groden Tettenser Groden (salt marsh), Schockumer Groden, Volkenser Groden areas; the Langlütjen I area and offshore tidal flats	Important breeding, resting and feeding area for wading and water birds, typical ecosystem with features including coastal tidal flats and dike foreland	
I/44	Rintzeln Rintzeln dike foreland and tidal flats between the Wremer Tief, Wurster Arm and Schmarrener Loch areas	Important resting and feeding area for wading and water birds, typical ecosystem with features including coastal tidal flats and dike foreland	Cabbage harvesting by the local population in the months of May and June, for its own consumption, in designated areas
I/45	Schmarrener Watt Tidal flats off the outer dike, over an area about 500 m wide, from Schmarren to Solthörn	Important eelgrass community	
I/45a	Paddingbütteler Außendeich (outer dike) Dike foreland between Paddingbüttel and Dorumer-Neufeld	Important breeding, resting and feeding area for wading and water birds, important habitat for characteristic animal and plant species, and typical ecosystem of dike forelands	Cabbage harvesting by the local population in the months of May and June, for its own consumption, in designated areas
I/46	Platen Robbenplate area, bounded to the east by the Wurster Arm and Tegeler Plate areas, between the Dwarsgat and Tegeler Rinne areas	Important section of seal habitat; important resting, moulting and feeding area for wading and water birds; typical ecosystem with features including sandbanks, coastal tidal flats	
I/47	Knechtsand Kleine Knechtsände, Eversand, Schwarze Gründe, Robben-Hohenhörn-Sände, Spiekaer Barre, Neuwerker Watt and Kleinwatt areas, and eastern Sahlenburger Watt (tidal flats), between Spieka-Neufeld and Werner Wald, and outer dike at the Arenscher Ufer (shore), with offshore tidal flat areas, bounded by the Wurster Arm and Tegeler Rinne areas, the outer boundary of the national park, the Robbenloch area, the Nordertill	Important section of seal habitat; important breeding, resting, moulting and feeding area for wading and water birds, typical ecosystem with features including sandbanks, coastal tidal flats, dike foreland; area with geologically important land forms (island formation)	Use of the swimming area, including the access way, by visitors staying at the Posterholungsheim hostel and Landschulheim school hostel; cabbage harvesting by the local population in the months of May and June, for its own consumption, in designated areas

	area to the south Schaafsand area, the Land (state) border with Hamburg, not including the south-western Sahlenburger Watt (tidal flats); summer dike in the Berensch-Arensch / Spieka Neufeld area, Spiekaer Tief (channel) and Weser-Elbe Wadden Sea navigation channel		
I/48	Eitzensand Sands west of the Weser-Elbe Wadden Sea navigation channel	Important section of seal habitat; importing resting, moulting and feeding area for wading and water birds; typical ecosystem with features including coastal tidal flats	
I/49	Duhner Anwachs Salt meadows with offshore tidal flats	Important breeding, resting and feeding area for wading and water birds; important habitat for characteristic animal and plant species	Operation of a beach railway on a route permitted by the national park's administration.
I/50	Duhner Heide Geest-area cliff and dunes bordering the area of core zone I/49 to the south-east	Important habitat of endangered animal and plant species and their communities; maritime dune areas and Geest-area cliff, with crowberry-coastal heath and scattered transition mires	Operation of a beach railway on a route permitted by the national park's administration.

[Aus Nds. GBBl. Nr. 4/2003, ausgegeben am 7.2.2003]

Article 3

Amendment of the Act on the "Wadden Sea of Lower Saxony" National Park

The Act on the "Wadden Sea of Lower Saxony" National Park of 11 July 2001 (Lower Saxony's Law Gazette (Nds. GVBl.) p. 443) is hereby amended as follows:

1. In Article 16 Sentence 2 and in Article 17 Sentence 2, the reference "Article 19 c of the Federal Nature Conservation Act" shall be replaced with the reference "Article 34 c of Lower Saxony's Nature Conservation Act".
2. In Article 29, a comma and the words "34 b" shall be inserted after the words "28 b".

Annex 18

Act for Amendment of the Act for Protection of the Wadden Sea of Schleswig-Holstein (National Park Act - NPG) of 17 December 1999

Act
for Amendment of the Act for Protection of the Wadden Sea of Schleswig-Holstein (National Park Act - NPG)
Of 17 December 1999

Gl.-Nr. (classification number): 791-6
Fundstelle (Source citation): GVOBl. Schl.-H. (Law Gazette of Schleswig-Holstein) 1999, p. 518

Change data: None

Introductory formula: The Act for the Protection of the Wadden Sea of Schleswig-Holstein (National Park Act) of 22 July 1985 (GVOBl. Schl.-H. (Law Gazette of Schleswig-Holstein) p. 202), with competencies and departmental designations last replaced by Ordinance of 24 October 1996 (GVOBl. (Law Gazette) p. 652), shall be given the following amended version:

Art. 1 Establishment of a National Park

(1) A national park has been established on Schleswig-Holstein's North Sea coast. It is named "Wadden Sea of Schleswig-Holstein" (Schleswig-Holsteinisches Wattenmeer") and comprises an area of about 441,500 ha.

It consists of

1. the Wadden Sea proper, with its tidal flats, gullies and other underwater areas,
2. the area's salt meadows, tidal channels, barrier islands, dunes and sandbanks,
3. the Hallig islands Habel, Norderoog, Süderoog, Südfall, Helmsand and Hamburger Hallig,
4. the supra-tidal sands, surrounded by tidal flats, of Japsand, Norderoogsand, Süderoogsand and Blauort and the island of Trischen,
5. the other small islands that have formed and are forming in the area, and
6. the North Sea, to the western boundary of the national park.

(2) The national park fulfils

1. criteria within the meaning of Article 4 (1) of Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds (OJ EC L 103 p. 1), last amended by Commission Directive 97/49/EC of 29 July 1997 (OJ EC L 223 p. 9),
2. the selection criteria set forth in Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (OJ EC L 206 p. 7), last amended by Council Directive 97/62/EC of 27 October 1997,
3. the criteria for a particularly sensitive sea area within the meaning of Resolution of the International Maritime Organization A.720(17) of 6 November 1991 (IMO PUBLICATION, Sales Number: IMO 142E) and for a rare and fragile ecosystem within the meaning of Article 194 (5) of the United Nations Law of the Sea Convention of 10 December 1982 (Federal Law Gazette 1994 II p. 1799.

Art. 2
Protection purpose and other purposes

(1) The national park serves the purpose of the protection and natural development of the Wadden Sea of Schleswig-Holstein and of the conservation of its special characteristics, beauty and natural condition. Natural processes shall be permitted to take place as unimpededly as possible. The national park shall be conserved as a habitat for the plant and animal species that occur in it naturally, as well as for the relationships occurring between such species and their habitats. Nature in its entirety, including its natural development, and including all plants, animals and ecosystems, has a value in and of itself and must be protected as such.

(2) Measures of coastal protection, including foreland protection and foreland reclamation, and of drainage of inland areas, shall not be restricted. Where the needs of coastal protection dictate, grazing of sheep, and removal of clay and sand, shall continue to be permitted.

(3)Unreasonable impairments of the interests and traditional uses of the local population shall be avoided. All usage interests shall be fairly balanced with the protection purpose in general, and shall be fairly balanced in individual cases. By having a positive impact on tourism and the region's image, nature conservation, via the national park, should promote sustainable development in the interest of improving the living and working conditions of the people who live in the general area.

(4)The provisions of the Land (state) water act and of the Land (state) nature conservation act shall not be affected, except insofar as Art. 11 (1) mandates a transitional provision.

Art. 3
Boundaries of the national park

(1) The boundaries of the national park shall be formed by

1. To the north: the German-Danish border,

2. To the east: a line 150 m distant from the seaward edge of the crown of the dike along the mainland coast, from the mean high-tide water line in the case of Geest-area slopes and from the dune base in the case of dunes; of the coast of Sankt Peter – Ording, to the north, from the boundary of the "Wadden Sea of North Friesland" ("Nordfriesisches Wattenmeer") nature conservation area (GVOBl. (Law Gazette) 1982, p. 198), in a westerly direction along the seaward boundary of the strip protecting the dike, to the Strandweg/Köhlbrand area; parking areas and areas with structures shall be excepted; between the Strandweg/Köhlbrand area and the bathing-area breakwater, on the seaward side of Hitzlöperweg; between the bathing-area breakwater and the Böhl lighthouse (Böhler Leuchtturm), on the seaward boundary of the strip protecting the dike; the parking area at the south passage area (Überfahrt Süd) shall be excluded; in the area of the planned reinforcement, pursuant to the General Plan for dike reinforcement, dike shortening and coastal protection, of the state protection dike (Landesschutzdeich), south-east of the Böhl lighthouse, on the seaward side of the relevant required salt-meadow area; in the south, to the property boundary of the municipality of Sankt Peter – Ording, beginning at the seaward boundary of the strip protecting the dike;

3. to the south: the northern tidal-flat edge of the main navigation channel of the Elbe River, and of the Medemrinne and Neufelder Rinne waterways, and of their connecting lines,

4. to the west: from the intersection of the northern boundary line of the German Wadden Sea with the 12-sea-mile boundary in a southerly direction to 54°30' N latitude; from there, in a north-easterly direction to 54°35'04" N latitude; from there, in an easterly direction to the 3-sea-mile boundary beginning at the baseline at 54° 35' 04" N latitude; from there, in a southerly direction, following the 3-sea-mile boundary,

5. around the North Frisian islands Sylt, Amrum, Föhr and Pellworm and the Hallig islands Oland, Langeneß, Gröde, Hooge and Nordstrandischmoor, a line at a distance of 150 m, on the seaward

side, from the seaward edge of the dike crown; in the case of undiked stretches of shoreline, 150 m, on the seaward side, from the embankment base of revetments, or from the dune base, or from the cut edge or from the mean high-tide water line, depending on which is present; in the case of the west beaches of the islands Sylt and Amrum, the boundary of the national park shall run 150 m to the seaward side of the mean high-tide water line.

(2) In derogation of Paragraph 1, the territory of the national park shall not include the embankments leading to the islands and the Hallig islands, as well as 150 m wide strips on either side of such embankments, nor shall it include the harbours and harbour infrastructure and those harbour access ways bounded, either on one or both sides, by guard embankments or jetties.

(3) In the case of tributary water bodies, with the exception of the Elbe River, their seaward boundaries shall apply.

(4) The overview map attached to this Act shows the territory of the national park outlined in black.

(5) The precise boundaries of the national park are shown on maps of the Federal Authority for Maritime Shipping and Hydrography (BSH), drawn to a scale of 1:150,000, or of 1:50,000 and, for the Elbe River estuary, to a scale of 1: 30,000, with a red boundary line. Such maps are part of this Act. Copies of the maps are archived by the Ministry for Environment, Nature and Forestry (Ministerium für Umwelt, Natur und Forsten; Ministry) in Kiel, the State office for the "Wadden Sea of Schleswig-Holstein National Park" (Nationalpark "Schleswig-Holsteinisches Wattenmeer" (national park office)) in Tönning, by the district administrators of the North Frisia districts in Husum and Dithmarschen in Heide, and by the landscape offices of Sylt, Amrum, Föhr-Land and Pellworm. The maps may be inspected during business hours.

(6) If the boundary features pursuant to Paragraph 1 change with respect to what is shown in the maps, the changed boundary features shall be the standard. The ministry, acting in agreement with the responsible boards of trustees, may adjust, by ordinance, the entries in the maps pursuant to Paragraph 5 Sentence 1 in order to bring them into line with changes in the national park's boundary features. Art. 53 (1) and (7) of the Land (state) nature conservation act shall apply mutatis mutandis.

Art. 4
Protection zones

The national park shall be divided into two protection zones; these are shown in the maps as protection zone 1 and protection zone 2. Protection zone 1 includes a zero-use area. The locations of the navigation channels shown in the maps pursuant to Art. 3 (5) shall be based on the official sea charts; these navigation channels, with the exception of the navigation channel located within the zero-use area, are not part of protection zone 1. For the areas of the Klotzenloch navigation channel, Flackstrom navigation channel and the navigation channel in the Wesselburener Loch area, agreements are to be reached regarding voluntary usage restrictions, for the period 1 July to 15 September of each year, for the protection of birds moulting in those areas. If the necessary protection for moulting birds cannot be achieved, via such voluntary agreements, by 31 December 2003, the ministry shall be authorised to specify the details of necessary protection measures via an ordinance issued in agreement with the Ministry for rural areas, agriculture, food and tourism (Ministerium für ländliche Räume, Landwirtschaft, Ernährung und Tourismus) and with the responsible board of trustees. The other areas, including the whale-conservation area (Art. 5 (4)) shall be protection zone 2. The boundaries of the protection zones are shown in the maps pursuant to Art. 3 (5). Art. 3 (6) shall apply mutatis mutandis.

Art. 5
Protection provisions

(1) In the national park, all actions, apart from expressly permitted measures and uses, are prohibited that could destroy, damage, change or lastingly disturb the protected area or its components. In particular, it shall not be permitted

1. to carry out interventions within the meaning of Art. 7 (1) of the state nature conservation act, or to carry out blasting or drilling,
2. to destroy or change animals' habitats and places of refuge, or plants' locations, to remove plants or parts of plants, to introduce plant species that are not native to the area, or to release animals of species that do not have habitats in the national park,
3. to pursue or trap wild animals, to disturb wild animals with noise or by other means, to injure or kill wild animals, or to damage or take possession of wild animals or their eggs or other developmental forms, or to permit dogs to run unleashed,
4. to set up tents or other mobile shelters, to store any kinds of things or to set up caravans for purposes of overnight stays,
5. to navigate or ride through the area's land and tidal-flat areas with vehicles of any kind within the meaning of Art. 1 of the Road traffic act (Straßenverkehrsgesetz), or with carriages or bicycles, or with air-cushion or amphibious vehicles,
6. to engage in hunting, with the exception of measures to protect game populations and of coastal protection measures,
7. to collect common cockles and razor clams; in addition, it shall not be permitted to collect other mussels without a permit pursuant to Art. 40 (1) of the State fisheries act (Landesfischereigesetz) on the basis of the programme for management of mussel resources,
8. to erect and operate wind power systems.

(2) In addition, it shall not be permitted to enter or navigate through protection zone 1 and those areas of protection zone 2 marked with signs announcing prohibitions. This shall not apply to owners, authorised users and their authorised usage representatives and to persons authorised by the competent authorities. The prohibitions required to achieve the protection purpose pursuant to Sentence 1 in protection zone 2 shall be issued by the national park office, within the framework of written agreements with the affected municipalities. The nature conservation associations serving the area shall be heard. The national park office shall also specify the manner in which prohibitions pursuant to Sentence 1 shall be communicated.

(3) In addition to the protection provisions set forth in paragraphs 1 and 2, all use of resources is prohibited in the zero-use area. The navigation channel may be used only for navigation.

(4) In addition to the protection provisions of Paragraph 1, in the whale-conservation area, it shall be prohibited to disturb whales significantly. Details regarding additional protection provisions shall be specified by ordinance by the Ministry, acting in agreement with the Ministry for rural areas, agriculture, food and tourism and with the responsible board of trustees. Such additional provisions consist of provisions within the meaning of Article 45 (2) of Council Regulation (EC) No. 850/98 of 30 March 1998 for conservation of fishery resources through technical measures for the protection of juveniles of marine organisms (OJ EC L 125 p. 1) and of No. 2.2 of the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas of 21 March 1992 (Federal Law Gazette II 1993, p. 1114).

Art. 6
Permissible measures and uses, exceptions, exemptions

(1) In the national park, the following actions, in addition to measures and uses pursuant to Art. 2 (2), shall remain permissible:

1. Measures for supply and waste management on the islands and Hallig islands;
2. Measures for preventing hazards that directly threaten human life and health;
3. Fulfilment of legally mandated tasks of federal waterway and shipping administration, and of measures for responding to accidents, including sea rescue and disaster management;
4. Measures for postal and telecommunications services;
5. Protection, management and development measures of the national park office, and long-term monitoring as permitted by the national park office, including research;
6. Use and maintenance of legally constructed structures, tourist facilities, roads and pathways;
7. Navigation with watercraft pursuant to Art. 5 of the Federal Waterway Act (Bundeswasserstraßengesetz), in the version promulgated on 4 November 1998 (Federal Law Gazette I p. 3294), and pursuant to legal provisions issued on the basis of that Act;
8. Clearance, using special equipment, of tidal channels used for drainage of inland areas or for harbour access.

(2) In protection zone 1, the following shall also be permitted, in addition to the measures and uses pursuant to Paragraph 1:

1. Entry into near-coastal tidal flats along the mainland coast, around the islands and the Hallig islands Oland, Langeneß, Gröde, Hooge and Nordstrandischmoor, also for purposes of bathing and of non-commercial fishing, in an area designated by the national park office, in agreement with affected municipalities; apart from definition of this area, routes for walking over tidal flats may also be specified by the national park office, acting on proposals, or by agreement with, the affected communities;
2. Commercial fishing for fish and shrimp, in the existing manner and to the existing extent, except in the zero-use area, and fishing for mussels in the framework of a permit pursuant to Art. 40 (1) and (41) of the State fisheries act (Landesfischereigesetz); fishing shall conform to the national park's protection purpose;
3. Non-commercial fishing outside of the area specified in Number 1, from boats, with the condition that for use of bottom trawl nets (Baumkurren) a permit from the supreme fisheries authority, acting in accordance with the national park office, shall be required;
4. Horseback-riding, travel by carriages and bicycles in the relevant areas designated by the national park office;
5. Walking on stepping stones, by canoeists, in the relevant areas designated by the national park office.

(3) In protection zone 2, the following shall also be permitted, in addition to the measures and uses pursuant to Paragraphs 1 and 2:

1. Fishing, in the existing manner and to the existing extent, for shrimp and fish; in the whale-conservation zone, taking account of Art. 5 (4),
2. Mussel fishing below the mean spring-tide low-water line, in keeping with Arts. 40 and 41 of the State fisheries act (Landesfischereigesetz); within the 3-sea-mile zone, only mussel fishing is permitted, while in the water-mixing zone, use of existing oyster aquaculture facilities shall be permitted,
3. Sand and gravel removal, for supply of the Hallig islands and other islands, in the existing manner and to the existing extent, with the permission of the national park office,

4. Removal of silt, saline spring water and sea water for personal needs and for purposes of spas in tourist facilities in the districts of Nordfriesland and Dithmarschen, in the existing manner and to the existing extent, in a relevant area designated by the national park office; any additional removals are subject to the permission of the national park office,
5. Construction and maintenance of harbours, including the related dumping of dredged material,
6. Drilling for and extraction of oil, solely from the approved Mittelplate A drilling and pumping rig, by agreement with the national park office,
7. Erection of structures for recreational bathing in the area of beaches for which concessions have been granted,
8. The use to which the Kingdom of Denmark is entitled in the area of the northern boundary of protection zone 2.

(4) The national park office may grant exceptions from the protection provisions of Art. 5 (1) Nos.1, 3 to 5 and (2) Sentence 1, where such action does not entail any significant impairment within the meaning of Art. 5 (1) Sentence 1. Otherwise, Art. 54 of the State nature conservation act (Landesnaturschutzgesetz) shall apply mutatis mutandis. Permission for exceptions granted by the hunting authority pursuant to Art. 5 (1) No. 6 shall be issued by agreement with the national park office.

(5) Where permitted measures and uses entail an impact on, or impairment of, natural assets and the landscape, Arts. 7 to 15 a of the State nature conservation act (Landesnaturschutzgesetz) shall apply. Compensation payments pursuant to Art. 8 b of the State nature conservation act (Landesnaturschutzgesetz) may be used for the purpose of measures to control movements of visitors in order to reduce disturbances in specific areas.

(6)The Ministry, acting in agreement with the responsible boards of trustees, may, by means of ordinances,

1. permit additional measures and uses in protection zone 2, for purposes of recreation, tourism and other economic purposes, and either on a generally or regionally limited basis, where such action is compatible with the protection purpose and does not conflict with other interests of nature conservation and landscape management;
2. specify the extent of measures and uses in cases covered by paragraph 1 No. 6, with regard to roads and pathways, and in cases covered by paragraph 3 Nos. 5 and 7, where the protection purpose necessitates such action.

Art. 7
National park office

(1) The national park office, located in Tönning, is responsible for the national park, as the relevant higher and lower nature conservation authority.

(2) In addition to its competencies under Arts. 45 b and 45 c of the state nature conservation act (Landesnaturschutzgesetz), the national park office shall also be responsible for:

1. informing the public about the national park, conducting educational activities and controlling movements of visitors and recreationers; this shall not affect the activities of private associations without support agreements or of the persons commissioned pursuant to paragraph 3,
2. carrying out and coordinating ecological monitoring, and providing the necessary relevant scientific basis for planning; this shall not affect the activities of the persons commissioned pursuant to paragraph 3,
3. regulating support provided by nature conservation associations within the meaning of Art. 21 d of the state nature conservation act (Landesnaturschutzgesetz) for the national park; in exceptional cases, several different nature conservation associations may be made responsible for the same support area.

(3) The administrative tasks pursuant to paragraph 2 Nos. 1 and 2 may be transferred to a private-law legal entity, with the entity's consent and pursuant to Art. 24 of the state administrative act (Landesverwaltungsgesetz), if such action is in the public interest and if the pertinent legal entity guarantees that it will properly fulfil the tasks so entrusted to it. The Ministry shall be responsible for such transfer of tasks, as well as for relevant revocation. The national park office shall be responsible for relevant supervision. Such supervision shall be confined to supervision limited to the legality of administrative activities, and it shall comprise the right to receive certain information, the right to issue orders, the right of substitution and the appointment of authorised representatives.

Art. 8
Boards of trustees

(1) One board of trustees (Kuratorium) shall be established, within the national park office, for each of the offshore areas of the Wadden Sea of Schleswig-Holstein belonging to the districts of Nordfriesland and Dithmarschen. The boundary between the areas covered by the boards of trustees shall be the middle of the main navigation channel in the Eider Estuary. Each board of trustees (Kuratorium) shall consist of the following members:

1. The district administrator (Landrat), as the chairperson,
2. Two persons appointed by the district assembly (Kreistag),
3. Five persons from the municipalities whose territories border the national park territory; these persons shall be appointed by the district association (Kreisverband) of the assembly of Schleswig-Holstein municipalities (Gemeindetag), in accordance with the cities belonging to the relevant districts,
4. A representative of the district's water and soil associations, which person shall be appointed by the Marschenverband association of Schleswig-Holstein,
5. The state commissioner for nature conservation,
6. A district commissioner for nature conservation, who shall be appointed by the lower nature conservation authority,
7. Two scientists appointed by the Ministry;
8. A person appointed by the Landesnaturschutzverband e.V. state nature conservation association,
9. One representative each from the sectors of tourism, sports, agriculture and fishing, which representatives shall be appointed by the Nordseebäderverband Schleswig-Holstein e.V. North Sea resort association, the Kreissportverband e.V. district athletic association and the relevant occupational associations,
10. One representative each for the sectors of industry/commerce and unions; these representatives, who ideally should reside within the relevant district area, shall be appointed by the Ministry,
11. Two representatives of supporting nature conservation associations, to be appointed by the Ministry.

The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and the Federal Ministry of Transport, Building and Housing (BMVBW) may each appoint a member to the boards of trustees. A deputy member shall be named, appointed or sent for each regular member. In each case, the members named pursuant to numbers 2, 7, 10 and 11 should consist of one man and one woman. Of the five persons named pursuant to number 3, at least two should be women. In each case, of the four persons to be named pursuant to number 9, two should be men and two should be women. Where only one person may be appointed and sent, women and men should alternate in the position. Similar provisions apply to all deputies.

(2) The Ministry may, by means of ordinances, specify the details pertaining to appointments, period of office and compensation for members of the board of trustees, as well as to the basic aspects of the rules of procedure.

(3) In addition to participating in issue of ordinances pursuant to Art. 3 (6), Art. 4, Art. 5 (4) und Art. 6 (6), the boards of trustees shall advise the national park office. The national park office shall take decisions regarding basic issues and long-term planning in agreement with the boards of trustees. Where agreement cannot be reached, the Ministry shall decide.

Art. 9
Compensation, offsets for hardships

Arts. 42 and 43 of the Land (state) nature conservation act shall apply mutatis mutandis. The Land (state) shall be responsible for making relevant compensation payments.

Art. 10
Administrative offences

(1) Anyone shall be deemed to have committed an administrative offence who, either intentionally or negligently,

1. in contravention of Art. 5 (1) Sentence 2 No. 1, carries out interventions within the meaning of Art. 7 of the state nature conservation act (Landesnaturschutzgesetz), or who carries out blasting or drilling,
2. in contravention of Art. 5 (1) Sentence 2 No. 2, destroys or changes habitats and places of refuge of animals, or locations of plants, or who removes plants or parts of plants or introduces non-native species, or who releases animals of species that do not have habitats in the national park,
3. in contravention of Art. 5 (1) Sentence 2 No. 3 pursues or traps wild animals, disturbs wild animals with noise or by other means, injures or kills wild animals, damages or takes possession of their eggs or other developmental forms, or permits dogs to run unleashed,
4. in contravention of Art. 5 (1) Sentence 2 No. 4, sets up tents or other mobile shelters, or stores things of any kind, or sets up caravans for purposes of overnight stays,
5. in contravention of Art. 5 (1) Sentence 2 No. 5, travels or rides over land or tidal-flat areas in vehicles of any kind within the meaning of Art. 1 of the Road traffic act (Straßenverkehrsgesetz) or in or with carriages, bicycles, hovercraft or amphibious vehicles, or rides on horseback, without proper authorisation, on land or tidal-flat areas,
6. in contravention of Art. 5 (1) Sentence 2 No. 6, engages in hunting,
7. in contravention of Art. 5 (1) Sentence 2 No. 7, fishes for mussels without a permit,
8. in contravention of Art. 5 (1) Sentence 2 No. 8, erects or operates wind power systems,
9. in contravention of Art. 5 (2) Sentence 1, enters or travels through protection zone 1 outside of designated areas, or enters or travels through areas of protection zone 2 marked with signs announcing that such entry or travel is prohibited,
10. in contravention of Art. 5 (3), uses resources within the zero-use area.

(2)In cases relative to

1. Paragraph 1 Nos. 1 and 7, administrative offences shall be punishable by a fine of up to one hundred thousand deutschmarks,
2. Paragraph 1 Nos. 2 to 6, and 8 to 10, administrative offences shall be punishable by a fine of up to ten thousand deutschmarks.

(3)Art. 57 (2) und Art. 57 a (1) No. 2 und (2) of the State nature conservation act (Landesnaturschutzgesetz) shall apply mutatis mutandis.

Art. 11
Transition arrangements, entry into force, expiry

(1) Leasing agreements for grazing of foreland area shall be renewed, for the existing relevant procedures and to the existing extent, as long as the leasing farms depend on the relevant areas economically.

(2) This Act shall enter into force on the day after it is promulgated.

(3) Upon the entry into force of this Act, the following ordinances shall expire:

1. State ordinance on the "Vogelfreistätte Hallig Norderoog" nature conservation area, in the Hooge municipal district, Nordfriesland district, of 1 July 1939 (Government law gazette (Reg. Amtsbl.) p. 208), last amended by ordinance of 24 October 1996 (Law Gazette of Schleswig-Holstein (GVOBl. Schl.-H.) p. 652),
2. State ordinance on the "Hallig Südfall" nature conservation area in the district of Nordfriesland of 22 January 1959 (Law Gazette of Schleswig-Holstein (GVOBl. Schl.-H.) p. 1), last amended by ordinance of 24 October 1996 (GVOBl. Schl.-H. p. 652),
3. State ordinance on the "Insel Trischen" nature conservation area in the district of Dithmarschen of 28 October 1959 (Law Gazette of Schleswig-Holstein (GVOBl. Schl.-H.) p. 206), last amended by ordinance of 24 October 1996 (GVOBl. Schl.-H. p. 652), ,
4. State ordinance on the "Hallig Süderoog" nature conservation area of 28 July 1977 (Law Gazette of Schleswig-Holstein (GVOBl. Schl.-H.) p. 206), last amended by ordinance of 24 October 1996 (GVOBl. Schl.-H. p. 652).

Annex 19

List of regional or sectoral management systems

List of regional or sectoral management systems

A) Germany

Order on the navigation in federal waterways in the National Parks in the area of the North Sea, 1997.
(Verordnung über das Befahren der Bundeswasserstraßen in Nationalparken im Bereich der Nordsee (NPNordSbefV), 1997)

A1)Niedersachsen

General administrative Regulation: Approval of hiking-, cycling-, horseback riding-, and carriage riding paths and routes; Official journal of the Regional Government Lüneburg and the Regional Government Weser-Ems, 2004.
(Allgemeinverfügung: Zulassung von Wander-, Rad-, Reit- und Kutschwegen, Amtsblatt Regierungsbezirk Lüneburg und Regierungsbezirk Weser-Ems, 2004).

General administrative Regulation: Approval of areas for leisure time fishing, resting areas in combination with bathing in the transition zone, locations for grounding of boats, Official journal of the Regional Government Lüneburg and the Regional Government Weser-Ems, 2004.
(Allgemeinverfügung: Zulassung von Flächen für die Freizeitfischerei, Lagerflächen für den Badebetrieb, Anlandeflächen für Boote, Amtsblatt Regierungsbezirk Lüneburg und Regierungsbezirk Weser-Ems,2004).

Management Plan Blue Mussel Fishery in the National Park Niedersächsisches Wattenmeer, Lower Saxony Ministry for Rural Areas, Food, Agriculture and Consumer Protection, Lower Saxony Ministry for the Environment, 2004.
(Bewirtschaftungsplan Miesmuschelfischerei im Nationalpark Niedersächsisches Wattenmeer, Niedersächsisches Ministerium für den ländlichen Raum, Ernährung, Landwirtschaft und Verbraucherschutz, Niedersächsisches Umweltministerium, 2004).

Management plan of the foreshore area of the Norderland Region, Buscherheller / Leybucht to Münstersommerpolder, 2003.
(Vorlandmanagementplan Norderland, Buscherheller / Leybucht bis Münstersommerpolder, 2003).

Detailed plans for local nature conservation management: Borkum, Juist, Langeoog, Wangerooge, Leybucht, Lütetsburger Sommerpolder, Sehestedt, Cuxhaven, 1987 – 2007.
(Detailpläne für lokales Naturschutzmanagement: Borkum, Juist, Langeoog, Wangerooge, Leybucht, Lütetsburger Sommerpolder, Sehestedt, Kräherbeeren- Küstenheiden Cuxhaven, 1987 - 2007).

Conception for education, information and public relation work in the National Park "Niedersächsisches Wattenmeer", 1990.
(Leitbild für die Bildungs-, Informations- und Öffentlichkeitsarbeit im Nationalpark Niedersächsisches Wattenmeer, 1990).

A2) Schleswig-Holstein

General administrative Regulation: Allowance of exemptions according to the National Park Act, Official journal of the Schleswig-Holstein government, 2004, p 800.
(Allgemeinverfügung: Zulassung von Ausnahmen nach dem Nationalparkgesetz, Amtsbl. Schleswig-Holstein 2004, S. 800).

Decree on the Boards of Trustees at the National Park Authority for the "National Park Schleswig-Holsteinisches Wattenmeer" in the version of July 1997.
(Landesverordnung über die Kuratorien beim Landesamt für den Nationalpark "Schleswig-Holsteinisches Wattenmeer" (Kuratorienverordnung Nationalpark) in der Änderung vom 11. Juli 1997).

Common guidelines fort the daily work of the National Park administration, 2003.
(Gemeinsame Leitsätze für die tägliche Arbeit der Nationalparkverwaltung, 2003).

Programme on the cultivation of mussel resources within the National Park "Schleswig-Holsteinisches Wattenmeer" according to § 40 of state fishery law in the version of July 4th 2006.
(Programm zur Bewirtschaftung der Muschelressourcen im Nationalpark „Schleswig-Holsteinisches Wattenmeer" gemäß § 40 Landesfischereigesetz (LFischG) in der Fassung vom 04. Juli 2006).

Voluntary agreement on the protection of moulting Shelducks with commercial (2003) and non commercial (1999) shrimp fishermen according to § 4 (4) National Park Act.
(Freiwillige Vereinbarung mit Krabbenfischern (2003) und Hobbyfischern (1999) nach § 4 Satz 4 Nationalparkgesetz zum Schutz mausernder Brandenten).

Saltmarsh Management Concept in Schleswig-Holstein – update 2007.
(*Vorlandmanagementkonzept (VMK) in Schleswig-Holstein – Fortschreibung 2007*).

Covenant with municipalities on entering the National Park in near-shore areas [of zone 1] according to § 6 National Park Act ("1000-meter-agreements"), 2004.
(Vereinbarungen mit den Gemeinden zum Betreten des Nationalparks im küstennahen Bereich nach § 6 Nationalparkgesetz („1000-Meter-Vereinbarungen"), 2004).

Contract between the state of Schleswig-Holstein and the municipality of St. Peter-Ording on the future development in the beach areas of St. Peter-Ording including utilisation of the beaches in the version of October 2006.
(Vertrag zwischen dem Land Schleswig-Holstein und der Gemeinde St. Peter-Ording über die künftige Entwicklung im Strandbereich vor St. Peter-Ording einschließlich der Nutzung des Strandes in der Fassung von Oktober 2006).

Concept fort the development of the Hamburger Hallig, 1991, Benchmark figures of a concept on utilisation of the Hamburger Hallig, 2000.
(Entwicklungskonzept Hamburger Hallig, 1991; Inhaltliche Eckpunkte eines Nutzungskonzeptes für die Hamburger Hallig, 2000).

Concept on recreational use, visitor information and environmental education at Westerhever Foreland and within the National Park (Framework-concept Westerhever), 2004.
(Konzept zur touristischen Nutzung, Besucherinformation und Umweltbildung im Westerhever Vorland und im Nationalpark (Rahmenkonzept Westerhever), 2004).

Framework-concept on environmental education in the National Park region, 2006.
(Rahmenkonzept für die Bildungsarbeit in der Nationalpark-Region, Juni 2006).

Concept of the pedagogic centre national park (PZN), 2007.
(Konzept des Pädagogischen Zentrums Nationalpark (PZN), Januar 2007).

Concept on the cooperation of information centres in the National Park region (Information concept), 2005.
(Konzept zur Zusammenarbeit der Informationszentren in der Nationalpark-Region (Infozentrums-Konzept), Juni 2005).

B) The Netherlands

General

- Nature Conservation Act 1998 *(Natuurbeschermingswet 1998)* (see annex xxx)
- Key Planning Decision Wadden Sea , 2007 (3rd Policy Document Wadden Sea) *(pkb Derde Nota Waddenzee)* (see annex xxx)
- Spatial Planning Act *(Wet op de ruimtelijke ordening)*
- Act on the Wadden Sea Council (*Wet op de Raad voor de Wadden)*
- Environmental Management Act *(Wet Milieubeheer)*
- Environmental Impact Assessment Decree 1994 (*Besluit M.e.r.1994)*.
- Calamities and Haevy Accidents Act *(Wet Rampen en zware ongevallen)*
- Public Works and Water Management Act 1900 *(Waterstaatswet)*
- Water Manegement Act 1989 *(Wet op de waterhuishouding)*
- Co-ordination Plan Calamity Control Wadden Sea *(Coördinatieplan Rampenbestrijding Waddenzee)*
- Monuments and Archaeological Sites Act (*Monumentenwet)*

- Dutch Management Plan Wadden Sea *(Beheersplan Waddenzee)*
- Implementation Programme Wadden Sea 2005 – 2010 *(Maatregelenprogramma 2005-2010)*
- Enforcement Programme Wadden Sea 2007 (each year a new enforcement programme is issued) *(Handhavingsprogramma 2007)*

- Inter Provincial Policy Plan (IBW) *(Interprovinciaal Beleidsplan)*
- Policy Plan of De Waddeneilanden Council 2006 – 2010 (*Beleidsplan van het samenwerkingsverband De Waddeneilanden)*
- Zoning Plans of the Province of Noord-Holland *(Streekplan provincie Noord-Holland)*
- Zoning Plan of the Province of Fryslân *(Streekplan provincie Fryslân)*
- Zoning Plan of he Province of Groningen *(Streekplan provincie Groningen)*
- Environmetal Regulations and Environmental Impact Assessments of the Provinces Noord-Holland, Fryslân and Groningen (*Provinciale milieuverordeningen en Milieu Effect Rapportages Waddenzee*)
- Zoning Plan of the Wadden Sea Municipalities *(Bestemmingsplannen van de afzonderlijke Waddenzeegemeenten)*
- General Police Regulations of the Wadden Sea Municipalities *(Gemeentelijke Algemene Politie Verordeningen)*
- Municipal Regulations Wadden Sea Area (*Gemeentelijke Verordening Waddenzeegebied*)

- Manegement Plan Schiermonnikoog 1999 – 2008 (*Beheerplan Nationaal Park Schiermonnikoog 1999 – 2008*)

- Management Plan Duinen van Texel (*Beheer- en Inrichtingsplan Nationaal Park Duinen van Texel, 2000)*

- Wadden Sea Management and Development Plan (in preparation at the moment of nomination) *(Beheer- en Ontwikkelplan)*
- Wadden Sea Managementplan Natura 2000 (in preparation at the moment of nomination) (*Beheerplannen N2000)*

- Provincial Tidal Flat Walking Bye-Law 1996 *(Provinciale Wadloopverordening, 1996)*
- Tidal Flat Walking Covenant *(Convenant Wadlopen)*
- Code of Conduct 'Wad I Love You' *(Gedragscode "Wad ik hou van jou")*
- Covenant Recreational Boating *(Convenant Vaarrecreatie)*

Annex 20

Regional declarations supporting the nomination

Regional declarations supporting the nomination

A) Resolution of the Regional Wadden Sea Board The Netherlands

Ms G. Verburg
Minister of Agriculture, Nature and Food Quality
Postbus 20401
2500 EK The Hague

5 December 2007

Re: Nomination of the Wadden Sea as World Heritage Site

Dear Minister Verburg,

On behalf of the regional Wadden Sea board I would like to inform you of the results of the recent regional consultation on the nomination of the Wadden Sea as World Heritage Site. The local and provincial governments involved were asked to agree to:
the nomination of the Wadden Sea as World Heritage Site on the basis of the proposed nomination dossier;
the signing of the Wadden Sea World Heritage site covenant by the representatives of the government bodies named in the covenant.

I am very pleased to inform you that all the local and provincial government bodies located on the Wadden Sea have agreed to both the nomination and the signing of the covenant. This fine achievement, in which the Wadden Sea focus group established by you played an inspirational role, means that the conditions placed on the nomination by the Dutch House of Representatives of the States General have been fully met. UNESCO also requires that nomination is based on adequate support in the region.

This result reflects the support for the nomination in the region. It also illustrates that the region sees opportunities in gaining World Heritage Status and is willing to continue to use the area wisely.

Yours sincerely,

E.H.T.M. Nijpels
Chair
Regional Wadden Sea Board

Minister of Education, Cultural Affairs and Science
Chair Central Committee on the Wadden Sea, Minister of Housing, Spatial Planning and the Environment

B) Resolution of the National Park Advisory Board of 14 November 2002

The Advisory Board supports the nomination to UNESCO of National Park “Lower Saxon Wadden Sea” (*Niedersächsisches Wattenmeer*) as a world heritage site.

The Advisory Board

- regards this measure as a recognition for the efforts made towards the protection of the Wadden Sea, efforts that find their legal expression in the National Park Act of Lower Saxony (*Niedersächsiches Nationalparkgesetz*) and
- hopes that new impetus will thereby be given to the development of the Wadden Sea Region.

The current status of protection and development is to be maintained on principle. The nomination as a world heritage site will not result in new or additional regulations being issued.

UNESCO does not represent an additional level of administration that is to be consulted in connection with plans and measures concerning the National Park. A recognition of the above National Park as a world heritage site will not affect the planning jurisdiction of the *Land* of Lower Saxony.

The National Park Act, with the instruments it has at its disposal, is able to capture and deal with natural developments and the solution of conflicts that may arise between conservation and human use.

The Advisory Board requests the Parliament of Lower Saxony (*Niedersächsischer Landtag*) to clarify the issues listed below in the form of a resolution to the effect that

- the nomination of the Wadden Sea to UNESCO as a world heritage site will take place in coordination with the countries of the Trilateral Wadden Sea Cooperation (Denmark, the Netherlands, Germany),
- the object of nomination in Lower Saxony will be National Park “Lower Saxon Wadden Sea” (*Niedersächsisches Wattenmeer*),
- recognition of the above as a world heritage site by UNESCO will not subject National Park “Lower Saxon Wadden Sea” (*Niedersächsisches Wattenmeer*) to additional control.

C) Agreement on the participation of the counties of Dithmarschen and Nordfriesland in the nomination process of the Wadden Sea as a World Heritage Site

between

the counties of Nordfriesland and Dithmarschen as regional representatives

and

the Minister of Agriculture, Environment and Rural Areas of the State of Schleswig-Holstein

Preamble

The following agreement shall, as binding fundament, regulate under which framework requirements a trilateral application to the UNESCO for the nomination of the National Park Wadden Sea as a World Heritage Site should be aimed at.

The signatories are in total agreement that the nomination of the Wadden Sea as World Heritage Site is to be regarded as fundamentally positive and an enhancement to the prestige of the region.

In order to take account of existing concerns and reservations in the region, the signatories agree to the following preconditions and corner points as a binding basis of agreement, from which regional approval to the nomination of the Wadden Sea as an UNESCO World Heritage Site will result.

Agreement

1. The application for nomination of the Wadden Sea as a World Heritage Site is to be confined to the area within the boundaries of the National Park (NPG 1999)

2. No buffer zone will be applied for. The Ministry of Agriculture, Environment and Rural Areas of Schleswig-Holstein ensures that if UNESCO should request a buffer zone this will not be met.

3. Use of the area is to comply with the regulations contained in the National Park Act. Nomination as a World Heritage Site is a distinction, which entails no changes to the current legal position. This means that no additional independent restrictions on land and marine use over and above existing laws (in particular the National Park Act and the State Nature Protection Act) will result from the status of a World Heritage Site for the National Park. In particular, measures for coastal protection, port development, maintenance or provision of ferry services independent of tidal conditions, traditional land usage and tourist developments which conform to current legislation may not be restricted as a result of the nomination of the area as a World Heritage Site.

4. To implement any changes wished for by UNESCO, either before or after the application is made, the understanding by both the Nordfriesland and Dithmarschen county councils and the neighbouring communities is necessary.

5. A Coordinating Group is to be set up, consisting of representatives of all signatories. This group, which will combine local and specialist interests, is to enact jointly on all matters in connection with the Schleswig-Holstein Wadden Sea as World Heritage Site. Therewith it is to provide the basis for further action.

6. The responsibilities for reporting to the UNESCO resulting from the nomination as World Heritage Site will be met by the state and federal authorities (and in the case of trilateral matters together with Denmark and the Netherlands by the Common Wadden Sea Secretariat) in consultation with the Coordinating Group. No additional costs arising from the reporting responsibilities, e.g. for additional monitoring or preparation of reports, above and beyond those included in the consultation, will be due from the communal side.

7. Use of the World Heritage distinction is governed by the UNESCO guidelines. The marketing is lead-managed by the Coordinating Group which, with the participation of the regional business associations and in particular the regional tourist marketing organisations and the National Park Authority, will designate a central point of contact for all marketing matters.

8. The signatories commit themselves jointly to the protection of the World Heritage Site from external threats and dangers (e.g. improvement of shipping safety, reduction of marine pollution by harmful substances and discharge of oil).

By this agreement, the Ministry of Agriculture, Environment and Rural Areas ensures that these preconditions will be met when applying for the nomination of the Schleswig-Holstein Wadden Sea as World Heritage Site.

Agreed by

The county councils of Nordfriesland and Dithmarschen

The State Government and State Parliament of Schleswig-Holstein

Appendix to the Agreement on the participation of the counties of Dithmarschen and Nordfriesland in the nomination of the Wadden Sea as a World Heritage Site

This appendix clarifies and defines the usages mentioned in paragraph 3. of the Agreement, exemplarily named in consultation with neighbouring communities, which are permissible and remain so in conformity with the regulations of the National Park Act (NPG), the State Nature Protection Act (LNatSchG), the State Water Act (LWG) and other legal source or voluntary agreements or contracts under public law. Their continuity is not affected by the nomination of the Wadden Sea as World Heritage Site.

- Coastal defence measures, including the conservation and proliferation of saltmarshes and the drainage of inland areas, are not to be restricted. The grazing of salt-marshes and the extraction of clay and sand are permitted if they are necessary for coastal defence purposes.
- Measures for supply and waste management on the islands and Hallig islands are not to be restricted.
- The World Heritage status will not impose restrictions on the measures necessary in harbours and for harbour access to ensure the maintenance of a ferry service independent of tidal conditions, or on clearance, using special equipment, of tidal channels used for drainage of inland areas.
- The application for nomination as a World Heritage Site is not to restrict tourist use and activities in the National Park and the adjacent mainland coast, or the islands of Sylt, Amrum, Föhr, Pellworm and Nordstrand and the Hallig islands. This applies i.a. to:
  - the use and maintenance of legally constructed structures, tourist facilities, roads and pathways and
  - leisure and recreational activities such as bathing, mudflat walking, surfing, riding and horse carriage excursions (e.g. Nordstrand – Südfall) in the respective permissible fashion and in and on the designated areas, tracks and paths including the so-called 1,000 m agreements with the neighbouring communities.

  Future tourism developments, insofar as they comply with current legislation, remain explicitly possible.
- The use of the beaches in St. Peter-Ording, including tourism development measures based on the public law contract between the municipality and the state of Schleswig-Holstein and the authorisation for special use of the sea coast, or other agreements between the municipality and the National Park Authority in the respective valid version, will not be restricted. This also applies beyond the current period of validity of the public law contract.
- The agreed aims and planned measures for the respective region contained in the development concept for the Hamburger Hallig or the framework concept for Westerhever including the development opportunities arising from these concepts will not be restricted.

Annex 23

Image inventory list

Annex 23

Image inventory list

No of photo	Form	Caption	Date of photo (month/year)	photographer (Abbreviation see below)	Copyright owner (Abbreviation see below)	Contact details of copyright owner: Address list below table	Non exclusive cession of rights
AERIAL PHOTOS							
001	jpg	Sandbank in the Wadden Sea	07/2007	MS	MS	MS	yes
002	jpg	Sandy tidal flats	07/2007	MS	MS	MS	yes
003	jpg	Hallig Suedfall Schleswig-Holstein	07/2006	MS	MS	MS	yes
004	jpg	Ice covered tidal flats	06/2002	MS	MS	MS	yes
005	jpg	Hallig Habel Schleswig-Holstein	07/2006	MS	MS	MS	yes
006	jpg	Hallig Norderoog Schleswig-Holstein	07/2006	MS	MS	MS	yes
007	jpg	Gullysystem in the Wadden Sea	04/2007	MS	MS	MS	yes
008	jpg	Megaripples	07/2006	MS	MS	MS	yes
009	jpg	Hallig Suederoog Schleswig-Holstein	07/2006	MS	MS	MS	yes
010	jpg	Tidal flat creek	07/2007	MS	MS	MS	yes
011	jpg	Kachelotplate Niedersachsen	01/2004	KDM	KDM	KDM	yes
012	jpg	Island of Luetjehoern in the Weser estuary	12/2005	HF	HF	HF	yes
013	jpg	Kachelotplate Niedersachsen	01/2004	KDM	KDM	KDM	yes
014	jpg	Tidal flats in the Wadden Sea	12/2005	HF	HF	HF	yes

ANIMALS							
		Fish and Invertebrates					
015	jpg	Blue jellyfish (*Rhizostoma octopus*) stranded at a beach of the east frisian islands.	09/2006	IZ	IZ	IZ	yes
016	jpg	Lion´s Mane Jellyfish *Cyanea capillata* washed ashore at "Vogelsand"-Sandbank.	06/2005	KJ	KJ	KJ	yes
027	jpg	Whiteweed (*Sertularia cupressia*) fixed to a blue mussel bed (*Mytilus edulis*).	06/1990	KJ	KJ	KJ	yes
018	jpg	Juvenile plumose anemone (*Metridium senile*) living in the gullies and on the mussel beds of the flats	unknown	MS	MS	MS	yes
019	jpg	Common hermit crab (*Pagurus bernhardus*) carrying a hydrozoan colony of *Hydractinia echinata* on its astropod "home"-shell	unknown	MS	MS	MS	yes
020	jpg	The dahlia anemone (*Urticina felina*) living on the sublittoral mussel beds of the Wadden Sea (photograph from Aquarium)	2006	IZ	IZ	IZ	yes
021	jpg	Lugworm (*Arenicola marina*) – most typical to the Wadden Sea flats	unknown	KJ	KJ	KJ	yes
022	jpg	Lugworm´s trace on the surface of a mudflat	2006	KK	KK	KK	yes
023	jpg	Lugworm Flats	2006	KK	KK	KK	yes
024	jpg	The King Rag (*Nereis virens*) represents the largest of the worm species living in the sediment of the tidal flats	1990	KJ	KJ	KJ	yes
025	jpg	Tubes of the polychaete worm *Pygospio elegans* washed out of the sediment by the tides	unknown	KJ	KJ	KJ	yes
026	jpg	Tubes of the polychaete *Spirorbis spirorbis* to the toothed wrack (*Fucus serratus*) on the mussel beds	1990	KJ	KJ	KJ	yes
027	jpg	Tubes of the polychaete *Lanice conchilega*	09/2006	IZ			yes
028	jpg	common periwinkles (*Littorina littorea*) live both on the flats an the mussel beds in the Wadden Sea	07/2002	CS	CS	CS	yes
029	jpg	Common periwinkles climb up a wooden pile	07/1992	KJ	KJ	KJ	yes
030	jpg	The mudsnail or Laver Spire shell (Hydrobia ulvae) can be washed ashore in millions after heavy storms and currents	06/1995	KJ	KJ	KJ	yes
031	jpg	Traces of mudsnails (*Hydrobia ulvae*) on the surface of a mudflat	06/1995	KJ	KJ	KJ	yes
032	jpg	The largest of all mussel species in the Wadden Sea flats is the sand gaper (*Mya arenaria*) with its long syphon tubes	unknown	KJ	KJ	KJ	yes
033	jpg	Sand gapers (*Mya arenaria*) are washed out and away by the strong currents of a gully	07/2005	KJ	KJ	KJ	yes

034	jpg	The peppery furrow shell (*Scrobicularia plana*) lives in the muddy sediments of the Wadden Sea	unknown	KJ	KJ	KJ	yes
035	jpg	The shells of the American razor mussel (*Ensis americanus*) are often washed ashore in thousands.	06/2005	KJ	KJ	KJ	yes
036	jpg	The American razor mussel (*Ensis americanus*) has been sighted in the Wadden Sea only since the late 1970ies	06/2005	KJ	KJ	KJ	yes
037	jpg	The pacific oyster (*Cassostrea gigas*) has only established itself during the last decade in the	unknown	MS	MS	MS	yes
038	jpg	A kaleidoscope of seashells	unknown	MS	MS	MS	yes
039	jpg	Barnacles in the intertidal (*Semibalanus balanoides*)	unknown	CS	CS	CS	yes
040	jpg	Brown shrimp (*Crangon crangon*)	unknown	KJ	KJ	KJ	yes
041	jpg	All over the flats: the green shore crab (*Carcinus maenas*) is the most common crab in the Wadden Sea	unknown	KJ	KJ	KJ	yes
042	jpg	Corophium volutator	unknown	KJ	KJ	KJ	yes
043	jpg	The chinese whool crab (*Eriocheir sinensis*) came around the globe with the ships in the 20th century	1990	KJ	KJ	KJ	yes
044	jpg	Little green sea urchin (*Psammechinus miliaris*)	1995	KJ	KJ	KJ	yes
045	jpg	Common Starfish (*Asterias rubens*)	1986	KJ	KJ	KJ	yes
046	jpg	A Starfish “embraces” a blue mussel	08/2002	KJ	KJ	KJ	yes
047	jpg	An armada of starfishes invades a blue mussel bed	06/2005	CS	CS	CS	yes
048	jpg	Turbot (*Scophthalmus maximus*) (Aquarium)	08/2007	IZ	IZ	IZ	yes
049	jpg	Plaice (*Pleuronectes platessa*) (Aquarium)	08/2007	IZ	IZ	IZ	yes
050	jpg	Three spinned stickleback (*Gasterosteus aculeatus*) in the seagrass beds (Aquarium)	05/2006	IZ	IZ	IZ	yes
		Birds					
051	jpg	Ground breeding cormorant	08/2006	KJ	KJ	KJ	yes
052	jpg	Ground nest of a cormorant	08/2006	KJ	KJ	KJ	yes
053	jpg	Ground Breeding Cormorant Colony	06/2000	KJ	KJ	KJ	yes
054	jpg	Spoonbills	05/2007	JK	JK	JK	yes
055	jpg	Barnacle Geese	04/2007	KE	KE	KE	yes
056	jpg	Barnacle Geese	unknown	MS	MS	MS	yes
057	jpg	Barnacle Geese	11/2007	MS	MS	MS	yes
058	jpg	Barnacle Geese	07/2006	KK	KK	KK	yes
059	jpg	Resting Brent Geese	04/2007	KE	KE	KE	yes
060	jpg	Grazing Brent Geese	07/2006	KK	KK	KK	yes
061	jpg	Pair of Brent Goose	11/2007	MS	MS	MS	yes

062	jpg	Pair of Eider Duck	unknown	JK	JK	JK	yes
063	jpg	Oyster catchers	unknown	JK	JK	JK	yes
064	jpg	Oystercatchers with Crews	unknown	JK	JK	JK	yes
065	jpg	Oystercatcher with blue mussel	unknown	JK	JK	JK	yes
066	jpg	Oystercatcher flock	07/2006	KK	KK	KK	yes
067	jpg	Oystercatchers	07/2006	KK	KK	KK	yes
068	jpg	Breeding Oystercatcher	unknown	MS	MS	MS	yes
069	jpg	Clutch of an Oystercatcher	unknown	KJ	KJ	KJ	yes
070	jpg	Flying Avocets	unknown	JK	JK	JK	yes
071	jpg	Grazing Avocets	07/2006	RG	RG	RG	yes
072	jpg	Kentish Plover at nest	07/2006	RG	RG	RG	yes
073	jpg	Flock of the Grey Plover	unknown	JK	JK	JK	yes
074	jpg	Knots	unknown	JK	JK	JK	yes
075	jpg	Flock of Knots	unknown	MS	MS	MS	yes
076	jpg	Flock of Knots	unknown	JK	JK	JK	yes
077	jpg	Resting Sanderlings	unknown	MS	MS	MS	yes
078	jpg	Resting Sanderlings at Westerhever Sand	unknown	MS	MS	MS	yes
079	jpg	Sanderlings at their feeding habitat	unknown	MS	MS	MS	yes
080	jpg	Dunlins	unknown	JK	JK	JK	yes
081	jpg	(Mostly) Dunlins and one Curlew Sandpiper	unknown	JK	JK	JK	yes
082	jpg	Resting Dunlins	unknown	JK	JK	JK	yes
083	jpg	Dunlin	unknown	MS	MS	MS	yes
084	jpg	Redshank	07/1992	KJ	KJ	KJ	yes
085	jpg	Redshank in vegetation	07/1992	KJ	KJ	KJ	yes
086	jpg	Bat Tailed Godwit	unknown	JK	JK	JK	yes
087	jpg	Flock of Bar Tailed Godwit	Unknown	JK	JK	JK	yes
088	jpg	Feeding Bar Tailed Godwits	Unknown	JK	JK	JK	yes
089	jpg	Resting Bar Tailed Godwits	unknown	JK	JK	JK	yes
090	jpg	Black Headed Gulls with Dunlins in front	unknown	JK	JK	JK	yes
091	jpg	Juvenile Black Headed Gulls	unknown	KK	KK	KK	yes
092	jpg	Black Headed Gulls	unknown	MS	MS	MS	yes
093	jpg	Black Headed Gulls	unknown	MS	MS	MS	yes
094	jpg	Herring Gulls	unknown	KK	KK	KK	yes
095	jpg	Lesser Black backed Gulls following shrimp fishery	2007	CS	CS	CS	yes
096	jpg	Lesser Black Backed Gulls resting on sandbank	unknown	MS	MS	MS	yes
097	jpg	Little Terns feeding chick	unknown	JK	JK	JK	yes
098	jpg	Colony of Sandwich Terns	1984	NPHW	NPHW	NPHW	yes

099	jpg	Flying Sandwich tern	unknown	JK	JK	JK	yes
100	jpg	Mating Arctic Terns	unknown	MS	MS	MS	yes
101	jpg	Flying Arctic Tern	unknown	MS	MS	MS	yes
102	jpg	Bird aggregations in the Wadden Sea	unknown	JK	JK	JK	yes
103	jpg	Bird aggregations in the Wadden Sea	unknown	JK	JK	JK	yes
104	jpg	Bird aggregations in the Wadden Sea	unknown	JK	JK	JK	yes
105	jpg	Bird aggregations in the Wadden Sea	unknown	JK	JK	JK	yes
106	jpg	Bird aggregations in the Wadden Sea	05/2006	KK	KK	KK	yes
107	jpg	Bird aggregations in the Wadden Sea	07/2001	RG	RG	RG	yes
		Mammals					
108	jpg	Harbour Porpoise of Sylt island	unknown	MS	MS	MS	yes
109	jpg	Grey Seal “Willy” watching people – Hoernum Harbour/Sylt	09/2000	KJ	KJ	KJ	yes
110	jpg	Grey Seal with pub (from the air) – East Frisia	unknown	HF	HF	HF	yes
111	jpg	Grey Sea (male) portrait	04/2007	MS	MS	MS	yes
112	jpg	Harbour Seal	1998	KJ	KJ	KJ	yes
113	jpg	Harbour Seal	1998	KJ	KJ	KJ	yes
114	jpg	Harbour Seal resting place	07/2006	KK	KK	KK	yes
115	jpg	Harbour Seal (female and juvenile)	07/2006	KK	KK	KK	yes
116	jpg	Harbour Seal resting place	07/2006	KK	KK	KK	yes
117	jpg	Harbour Seals	07/2006	KK	KK	KK	yes
118	jpg	Harbour Seals resting on sandbank	10/2005	KJ	KJ	KJ	yes
119	jpg	Harbour Seals on Sandbank	07/2006	KK	KK	KK	yes
120	jpg	Harbour Seal (female and juvenile)	07/2006	KK	KK	KK	yes
121	jpg	Harbour Seal sandbank at the island of Norderney	10/2007	IZ	IZ	IZ	yes
122	jpg	Harbour Seal sandbank at the island of Norderney	10/2007	IZ	IZ	IZ	yes
123	jpg	Harbour Seal sandbank at the island of Wangerooge	10/2007	IZ	IZ	IZ	yes
124	jpg	Harbour Seal (portrait)	unknown	MS	MS	MS	yes
125	jpg	Harbour Seal (portrait)	04/2007	MS	MS	MS	yes
126	jpg	Harbour Seal (portrait)	04/2007	MS	MS	MS	yes
127	jpg	Harbour Seal on Wadden Sea flats	07/2006	MS	MS	MS	yes

PLANTS							
128	jpg	Ammophila arenaria	09/2005	KK	KK	KK	yes
129	jpg	Ammophila arenaria at the island of Norderney	06/2006	NH	NH	NH	yes
130	jpg	Armeria maritima at the island of Spiekeroog	05/2007	NH	NH	NH	yes
131	tiff	Armeria maritima	05/2000	KJ	KJ	KJ	yes
132	jpg	Artemisia maritima	07/2006	NH	NH	NH	yes
133	jpg	Artemisia – Suaeda – Atriplex – complex vegetation	08/2005	JB	JB	JB	yes
134	jpg	Aster triposum	09/2006	KE	KE	KE	yes
135	jpg	Atriplex (Halimione) portulacoides	05/2007	NH	NH	NH	yes
136	jpg	Bulboschoenus maritimus	07/2007	NH	NH	NH	yes
137	jpg	Cakile maritima	unknown	KJ	KJ	KJ	yes
138	jpg	Cakile maritima	unknown	KJ	KJ	KJ	yes
139	jpg	Dactylorhiza majalis at the island of Langeoog	06/2006	JB	JB	JB	yes
140	jpg	Diatoms and green microalgae covering tidal flats	2005	KJ	KJ	KJ	yes
141	jpg	Diatoms and green microalgae covering tidal flats	2005	KJ	KJ	KJ	yes
142	jpg	Diatoms on Wadden Flats at the island of Norderney	09/2006	IZ	IZ	IZ	yes
143	jpg	Drosera spec at the island of Norderney	06/2007	NH	NH	NH	yes
144	jpg	Empetrum nigrum	06/2007	NH	NH	NH	yes
145	jpg	Eryngium maritimum at the island of Juist	09/2003	NH	NH	NH	yes
146	jpg	Eryngium maritimum	07/2007	JH	JH	JH	yes
147	jpg	Honkenya peloides	05/2007	NH	NH	NH	yes
148	jpg	Honkenya peloides	unknown	KJ	KJ	KJ	yes
149	jpg	Limonium vulgare	07/2007	NH	NH	NH	yes
150	jpg	Limonium vulgare - Caeciliengroden	05/2007	NH	NH	NH	yes
151	jpg	Limonium	08/2003	KJ	KJ	KJ	yes
152	jpg	Limonium vulgare at the island of Langeoog	07/2006	NH	NH	NH	yes
153	jpg	Ononis spinosa	07/2006	NH	NH	NH	yes
154	jpg	Plantago coronopus at the island of Spiekeroog	05/2007	NH	NH	NH	yes
155	jpg	Pyrola rotundifolia at the island of Spiekeroog	08/2005	JB	JB	JB	yes
156	jpg	Salicornia spec	unknown				
157	jpg	Salicornia spec at the island of Norderney	09/2006	IZ	IZ	IZ	yes
158	jpg	Salicornia spec	09/2005	KK	KK	KK	yes
159	jpg	Salicornia spec	unknown	MS	MS	MS	yes
160	jpg	Salicornia stricta at the island of Langeoog	2005	JB	JB	JB	yes
161	jpg	Salicornia stricta	08/2006	KJ	KJ	KJ	yes

162	jpg	Salicornia stricta	06/2005	KJ	KJ	KJ	yes
163	jpg	Sedum acre	06/2005	KJ	KJ	KJ	yes
164	jpg	Spartina anglica north of the island of Amrum	11/2007	KJ	KJ	KJ	yes
165	jpg	Spergularia salina	08/2007	KJ	KJ	KJ	yes
166	jpg	Spergularia salina	07/2007	NH	NH	NH	yes
167	jpg	Triglochin maritima	02/007	NH	NH	NH	yes
168	jpg	Viola tricolor	05/2006	IZ	IZ	IZ	yes
169	jpg	Zostera marina	05/2005	GM	GM	GM	yes
HABITATS							
		Beaches					
170	jpg	Beach with mussel shells on Kachelot	09/2006	NH	NH	NH	yes
171	jpg	Beach on Dutch island	09/2005	KK	KK	KK	yes
172	jpg	Beach on the island of Norderney	10/2007	IZ	IZ	IZ	yes
173	jpg	Sky over beach on the island of Norderney	10/2007	IZ	IZ	IZ	yes
174	jpg	Beach and dunes on the island of Wangerooge	07/2004	IZ	IZ	IZ	yes
175	jpg	Sand drift on beach	05/2006	MS	MS	MS	yes
176	jpg	Waves on beach	unknown	MS	MS	MS	yes
177	jpg	Waves on beach	unknown	MS	MS	MS	yes
178	jpg	Beach on Kachelot	09/2006	NH	NH	NH	yes
179	jpg	Mussel shells on beach on the island of Norderney	10/2007	IZ	IZ	IZ	yes
180	jpg	Tern clutch on beach	07/1999	?	?	?	yes
181	jpg	Beach on Kachelot	09/2006	NH	NH	NH	yes
182	jpg	Beach and dunes on the island of Norderney	10/2007	IZ	IZ	IZ	yes
183	jpg	Beach with Cakile maritima	09/2006	NH	NH	NH	yes
184	jpg	Beach on the island of Wangerooge	03/2007	NH	NH	NH	yes
185	jpg	Beach on the island of Norderney	10/2007	IZ	IZ	IZ	yes
186	jpg	Beach on a summer day	unknown	MS	MS	MS	yes

		Dunes					
187	jpg	Primary dunes on the island of Wangerooge	07/2004	IZ	IZ	IZ	yes
188	jpg	Pioneer dunes	08/2007	MS	MS	MS	yes
189	jpg	Dunes	unknown	KJ	KJ	KJ	yes
190	jpg	White dunes on the island of Norderney	08/2007	NH	NH	NH	yes
191	jpg	Dune cliff on the island of Langeoog	06/2007	NH	NH	NH	yes
192	jpg	Dunes	unknown	JK	JK	JK	yes
193	jpg	Dunes with Cakile maritima	09/2006	KJ	KJ	KJ	yes
194	jpg	Dunes on the island of Norderney	07/2007	NH	NH	NH	yes
195	jpg	Dune development by cockle shells	10/2007	IZ	IZ	IZ	yes
196	jpg	Dunes on the island of Norderney	06/2006	NH	NH	NH	yes
197	jpg	Dunes on Boschplaat	07/2007	JH	JH	JH	yes
198	jpg	Dunes on the island of Norderney	10/2007	IZ	IZ	IZ	yes
199	jpg	Dunes	unknown	KK	KK	KK	yes
200	jpg	Dune development on Kachelot	09/2006	NH	NH	NH	yes
201	jpg	Primary dunes on the island of Spiekeroog	05/2007	NH	NH	NH	yes
202	jpg	Dunes on the island of Norderney	07/2007	NH	NH	NH	yes
203	jpg	Brown dunes on the island of Langeoog	07/2006	NH	NH	NH	yes
204	jpg	Dunes on the island of Norderney	06/2006	NH	NH	NH	yes
205	jpg	White dune on the island of Spiekeroog	05/2007	NH	NH	NH	yes
206	jpg	Brown dune	05/2005	NH	NH	NH	yes
207	jpg	Grey dune on the island of Spiekeroog	05/2007	NH	NH	NH	yes
208	jpg	Dunes after storm	07/2007	JH	JH	JH	yes
209	jpg	White dune	05/2007	NH	NH	NH	yes
210	jpg	Brown dune on the island of Spiekeroog	05/2007	NH	NH	NH	yes
211	jpg	Coastal dune cliff near Cuxhaven	05/2005	NH	NH	NH	yes
212	jpg	Brown dunes on the island of Spiekeroog	05/2006	IZ	IZ	IZ	yes
213	jpg	Brown dunes on the island of Spiekeroog	08/2007	IZ	IZ	IZ	yes
214	jpg	Dune with Empetrum nigrum	05/2007	NH	NH	NH	yes
215	jpg	Dunes on the island of Norderney	10 2007	IZ	IZ	IZ	yes
216	jpg	Dune landscape on the island of Spiekeroog	05/2007	NH	NH	NH	yes
217	jpg	Border dunes on the island of Norderney	10/2007	IZ	IZ	IZ	yes
		Mussel beds					
218	jpg	Blue mussel bed	unknown	KJ	KJ	KJ	yes

219	jpg	Cockle flats	unknown	KJ	KJ	KJ	yes
220	jpg	Cockle flat	09/2006	NH	NH	NH	yes
221	jpg	Cockles	09/2006	NH	NH	NH	yes
222	jpg	Mussel bed near the island of Griend	02/2007	JK	JK	JK	yes
223	jpg	Mussel bed near the island of Borkum	07/2007	GM	GM	GM	yes
224	jpg	Mussels	07/2005	GM	GM	GM	yes
225	jpg	Mussel bed Hoher Weg	05/2005	GM	GM	GM	yes
226	jpg	Mytilus edulis	unknown	KJ	KJ	KJ	yes
227	jpg	Mytilus edulis	11/2005	KJ	KJ	KJ	yes
228	jpg	Mussel bed	07/2004	GM	GM	GM	yes
		Salt marshes					
229	jpg	Saltmarsh	unknown	?	?	?	
230	jpg	Saltmarsh Boschplaat after stormtide	09/2007	JH	JH	JH	yes
231	jpg	Saltmarsh gully Hornhuisterwad	unknown	JH	JH	JH	yes
232	jpg	Saltmarsh Limonium vulgare Cupido polder	07/2007	JH	JH	JH	yes
233	jpg	Saltmarsh Hornhuisterwad	unknown	JH	JH	JH	yes
234	jpg	Saltmarsh Boschplaat with Artemisia and Limonium	07/2007	JH	JH	JH	yes
235	jpg	Saltmarsh Boschplaat	unknown	JK	JK	JK	yes
236	jpg	Saltmarsh on the island of Griend	unknown	JK	JK	JK	yes
237	jpg	Flooded saltmarsh	unknown	JK	JK	JK	yes
238	jpg	Saltmarsh on the island of Juist	09/2006	NH	NH	NH	yes
239	jpg	Saltmarsh	unknown	KK	KK	KK	yes
240	jpg	Saltmarsh	unknown	KK	KK	KK	yes
241	jpg	Saltmarsh	unknown	KK	KK	KK	yes
242	jpg	Saltmarsh	unknown	KK	KK	KK	yes
243	jpg	saltmarsh with salicornia	09/2005	KK	KK	KK	yes
244	jpg	Saltmarsh	unknown	KK	KK	KK	yes
245	jpg	Saltmarsh gully	09/2003	JB	JB	JB	yes
246	jpg	Saltmarsh gully on the island of Langeoog	09/2003	JB	JB	JB	yes
247	jpg	Saltmarsh gully on the island of Norderney	07/2007	NH	NH	NH	yes
248	jpg	Saltmarsh Limonium Artemisia	07/2007	JH	JH	JH	yes
249	jpg	Saltmarsh on the island of Juist	09/2003	NH	NH	NH	yes
250	jpg	Saltmarsh gully on the island of Norderney	09/2006	IZ	IZ	IZ	yes
251	jpg	Saltmarsh gully on the island of Wangerooge	05/2006	IZ	IZ	IZ	yes
252	jpg	Saltmarsh rainbow	08/2006	MS	MS	MS	yes
253	jpg	Saltmarsh gully on the island of Norderney	07/2007	NH	NH	NH	yes

254	jpg	Saltmarsh gully wooden bridge	unknown	MS	MS	MS	yes
255	jpg	Saltmarsh on the island of Juist	09/2003	NH	NH	NH	yes
256	jpg	Saltmarsh	08/2007	MS	MS	MS	yes
257	jpg	Saltmarsh gully on the island of Norderney	04/2004	NH	NH	NH	yes
258	jpg	Saltmarsh Westerhever	unknown	MS	MS	MS	yes
259	jpg	Saltmarsh waves erosion	unknown	MS	MS	MS	yes
260	jpg	Saltmarsh on the island of Wangerooge	06/2007	NH	NH	NH	yes
		Special aspects					
261	jpg	Brackish water vegetation in the Weser estuary	08/2003	IZ	IZ	IZ	yes
262	jpg	Kachelotplate	09/2006	NH	NH	NH	yes
263	jpg	Shell beach near Campen Ems estuary	03/005	NH	NH	NH	yes
264	jpg	Shell beach near Campen detail	03/2005	NH	NH	NH	yes
265	jpg	Swimming bog at Sehestedt in the Jade Bay	02/2007	NH	NH	NH	yes
266	jpg	Swimming bog at Sehestedt in the Jade Bay	09/2006	MS	MS	MS	yes
267	jpg	Swimming bog at Sehestedt in the Jade Bay	09/2006	MS	MS	MS	yes
268	jpg	Spiekeroog Ostplate	06/2007	MS	MS	MS	yes
		Tidal flats					
269	jpg	Tidal flats	unknown	?	?	?	
270	jpg	Tidal flat structures	unknown	KJ	KJ	KJ	yes
271	jpg	Tidal flat erosion	unknown	KJ	KJ	KJ	yes
272	jpg	Tidal flat in the Wadden Sea of Friesland	unknown	JH	JH	JH	yes
273	jpg	Tidal flat Hornhuisterwad	unknown	JH	JH	JH	yes
274	jpg	Tidal flat OerdAmeland	unknown	JH	JH	JH	yes
275	jpg	Reflections at Wierummerwad	unknown	JH	JH	JH	yes
276	jpg	Tidal flats at Cupidopolder Boschplaat	unknown	JH	JH	JH	yes
277	jpg	Birdwatchers hut at Engelsmanplaat	08/2001	JH	JH	JH	yes
278	jpg	Tidal flat structures	unknown	JK	JK	JK	yes
279	jpg	Tidal flat	unknown	JK	JK	JK	yes
280	jpg	Bird tracks on tidal flat	07/2006	KK	KK	KK	yes
281	jpg	Tidal flat gully structures	07/2006	KK	KK	KK	yes
282	jpg	Tidal flats at the harbour of List on Sylt	unknown	KJ	KJ	KJ	yes
283	jpg	Mussel cemetery gully ebb tide	02/2005	KJ	KJ	KJ	yes
284	jpg	Salicornia tidal flat on the island of Norderney	09/2006	IZ	IZ	IZ	yes
285	jpg	Tidal flat gully in the Jade Bay	06/2007	NH	NH	NH	yes
286	jpg	Tidal flat gully structures	unknown	KJ	KJ	KJ	yes

287	jpg	Sandy flat near the island of Norderney	10/2007	IZ	IZ	IZ	yes
288	jpg	Sandy flats	unknown	KJ	KJ	KJ	yes
289	jpg	Tidal flats	unknown	MS	MS	MS	yes
290	jpg	Shallow waters	unknown	MS	MS	MS	yes
291	jpg	Gully outlet	unknown	MS	MS	MS	yes
292	jpg	Gully structure	08/2005	MS	MS	MS	yes
293	jpg	Shorebirds on tidal flats	04/2007	MS	MS	MS	yes
294	jpg	Icy tidal flats	unknown	MS	MS	MS	yes
295	jpg	Icy tidal flats	unknown	MS	MS	MS	yes
296	jpg	Sand ripples	unknown	MS	MS	MS	yes
297	jpg	Surface of sandy flats	unknown	KJ	KJ	KJ	yes
298	jpg	Surface of sandy flats	unknown	KJ	KJ	KJ	yes
299	jpg	Tidal flats on the island of Norderney	09/2006	IZ	IZ	IZ	yes
300	jpg	Tidal flat ripples	11/2005	KJ	KJ	KJ	yes
IMPRESSIONS							
301	jpg	Waves	09/2005	KK	KK	KK	yes
302	jpg	Sunset on tidal flats	01/2001	JK	JK	JK	yes
303	jpg	Dynamic light	12/2005	JH	JH	JH	yes
304	jpg	Dynamic light	09/2007	JH	JH	JH	yes
305	jpg	Clouds in Light	12/2005	JH	JH	JH	yes
306	jpg	Snowstorm on the island of Schiermonnikoog	03/2006	JH	JH	JH	yes
307	jpg	Island of Terschelling	12/2005	JH	JH	JH	yes
308	jpg	Evening light	12/2005	JH	JH	JH	yes
309	jpg	Winter impressions	12/2006	JH	JH	JH	yes
310	jpg	Engelsmanplaat	09/2007	JH	JH	JH	yes
311	jpg	Sun reflections on saltmarshes	09/2005	KK	KK	KK	yes
312	jpg	Dark clouds	09/2005	KK	KK	KK	yes
313	jpg	Tidal flats	09/2005	KK	KK	KK	yes
314	jpg	Tidal flats	09/2005	KK	KK	KK	yes
315	jpg	Sunset on the Wadden Sea	01/2004	KJ	KJ	KJ	yes
316	jpg	Worms and the horizon	08/2005	MS	MS	MS	yes
317	jpg	Meandering gully	08/2005	MS	MS	MS	yes
318	jpg	Rising tide	08/2007	MS	MS	MS	yes
319	jpg	Clouds above sandbank	08/2005	MS	MS	MS	yes
320	jpg	Icy tidal flats	02/2006	MS	MS	MS	yes
321	jpg	Sunset	04/2007	MS	MS	MS	yes

322	jpg	Brushwood groins	09/2007	MS	MS	MS	yes
323	jpg	Sunrise	09/2007	MS	MS	MS	yes
324	jpg	Winter storm	12/2006	MS	MS	MS	yes
325	jpg	Snow clouds	03/2006	MS	MS	MS	yes
326	jpg	Waves	05/2007	NH	NH	NH	yes
327	jpg	Clouds in special light	05/2005	GM	GM	GM	yes
MAN AND WADDEN SEA							
328	jpg	Navigational sign in fog	02/2007	KE	KE	KE	yes
329	jpg	Favourite meal crangon crangon	03/2007	KJ	KJ	KJ	yes
330	jpg	Sigh of the National Park	09/2006	KJ	KJ	KJ	yes
331	jpg	Shrimp fishery	2006	KK	KK	KK	yes
332	jpg	Charter boat	07/2005	KK	KK	KK	yes
333	jpg	Island ferry	07/2007	KK	KK	KK	yes
334	jpg	Horse trail	2006	JK	JK	JK	yes
335	jpg	Land reclamation	03/2007	JH	JH	JH	yes
336	jpg	Shrimp fishery	2006	KK	KK	KK	yes
337	jpg	Shrimp fishery	2006	KK	KK	KK	yes
338	jpg	Charter boat	07/2005	KK	KK	KK	yes
339	jpg	Charter boat	07/2005	KK	KK	KK	yes
340	jpg	Sailing boats	07/2005	KK	KK	KK	yes
341	jpg	Boat on tidal flats and man walking	07/2005	KK	KK	KK	yes
342	jpg	Boat on tidal flats	07/2005	KK	KK	KK	yes
343	jpg	Hallig Habel	04/2005	MS	MS	MS	yes
344	jpg	Fish traps	09/2007	MS	MS	MS	yes
345	jpg	Sheep grazing	09/2005	MS	MS	MS	yes
346	jpg	House on the Hamburger Hallig	04/2005	MS	MS	MS	yes
347	jpg	Lighthouse Westerhever	04/2005	MS	MS	MS	yes
348	jpg	Storm around the Halligen	01/2007	MS	MS	MS	yes
349	jpg	Winter storm at coast line	01/2007	MS	MS	MS	yes
350	jpg	Rolling waves can cause erosion	03/2007	MS	MS	MS	yes
351	jpg	Waves at Hallig	03/2007	MS	MS	MS	yes
352	jpg	Tourist group on mud flats	06/2005	MS	MS	MS	yes
353	jpg	Tourists on discovery tour	06/2005	MS	MS	MS	yes
354	jpg	Group of people on mud flats at rising tide	06/2005	MS	MS	MS	yes
355	jpg	Group of rangers	11/2003	MS	MS	MS	yes
356	jpg	Rangers watching birds	11/2003	MS	MS	MS	yes

357	jpg	Rangers in saltmarsh	11/2003	MS	MS	MS	yes
358	jpg	Rangers at work	02/2006	MS	MS	MS	yes
359	jpg	Ranger explaining area	07/2005	MS	MS	MS	yes
360	jpg	Beach walking	06/2007	MS	MS	MS	yes
361	jpg	Walking on dunes	06/2007	MS	MS	MS	yes
362	jpg	Horse riding at beach	06/2007	MS	MS	MS	yes
363	jpg	Scientific measures in saltmarsh	09/2005	MS	MS	MS	yes
364	jpg	Measures in saltmarsh	09/2005	MS	MS	MS	yes
365	jpg	Work with brushwood groins	04/2005	MS	MS	MS	yes
366	jpg	Groins maintenance work	04/2005	MS	MS	MS	yes
367	jpg	Tourists at Hallig	06/2005	MS	MS	MS	yes
368	jpg	Fishing boat	06/2006	MS	MS	MS	yes
369	jpg	Boat trip	06/2006	MS	MS	MS	yes
370	jpg	Sailing boat	07/2006	MS	MS	MS	yes
371	jpg	Historic boat	05/2006	MS	MS	MS	yes
372	jpg	Tracks on the beach of the island of Spiekeroog	05/2006	IZ	IZ	IZ	yes

Abbreviations and contact details of copyright owners (name, address, phone, fax and e-mail):

CS: Claus Schulz, Nationalparkverwaltung, Virchowstr.1, D-26382 Wilhelmshaven, Germany, phone +49(0)4421 911274, fax +49(0)4421 911280, e-mail: claus.schulz@nlpv-wattenmeer.niedersachsen.de

GM: Dr. Gerald Millat, Nationalparkverwaltung, Virchowstr.1, D-26382 Wilhelmshaven, Germany, phone +49(0)4421 911298, fax +49(0)4421 911280, e-mail: gerald.millat@nlpv-wattenmeer.niedersachsen.de

HF: Dr. Hubert Farke, Nationalparkverwaltung, Virchowstr.1, D-26382 Wilhelmshaven, Germany, phone +49(0)4421 911281, fax +49(0)4421 911280, e-mail: hubert.farke@nlpv-wattenmeer.niedersachsen.de

HHB: Prof. Hans-Heiner Bergmann, Landstr. 44, D-34454 Arolsen, Germany, phone +49(0) 5691 628231, fax +49(0)5691 628233, e-mail: bergmannhh@web.de

IZ: Dipl. Ing. Imke Zwoch, Nationalparkverwaltung, Virchowstr.1, D-26781 Wilhelmshaven, Germany, phone +49(0)4421 911290, fax +49(0)4421 911280, e-mail: imke.zwoch@nlpv-wattenmeer.niedersachsen.de.

JB: Jan Barkowski, Brommystr. 2, 26384 Wilhelmshaven, Germany, phone +49(0)4421 944 208, e-mail: jan.barkowski@icbm.terramare.de

JH: Jan Huneman, Douwe Totlaan 46, 8881CZ West Terschelling, The Netherlands, phone +31(0)6 20445233, e-mail: jan@waddenfotografie.nl

JK: Jan van de Kam, Deurneseweg 1, 5766 PH Griendtsveen, The Netherlands, phone +31(0)493 529306, e-mail: JK@worldonline.nl

KDM: Klaus-Dieter Meinen, Nationalparkverwaltung, Virchowstr.1, D-26382 Wilhelmshaven, Germany, phone +49(0)4421 911279, fax +49(0)4421 911280, e-mail: klaus-dieter.meinen@nlpv-wattenmeer.niedersachsen.de

KE Kurt Eisermann, Wilhelm-Volkmer-Weg 40, D-27476 Cuxhaven, Germany, phone +49(0)4721 29656, e-mail: KurtEisermann@t-online.de.

KJ Dr. Klaus Janke, Behörde für Stadtentwicklung und Umwelt; Abt. Naturschutz, Stadthausbrücke 8, D-20355 Hamburg, Germany, phone +49(0)40 42840 3392, fax +49(0)40 42840 3552, e-mail: klaus.janke@bsu.hamburg.de.

KK: Klaas Kreuijer, Ministerie van Landbouw, Natuur en Voedselkwaliteit, Directie Noord, Postbus 30032, 9700 RM Groningen, phone +31(0)50 5992300, fax +31 (0)50 5002399, e-mail: k.kreuijer@minlnv.nl

MS: Dr. Martin Stock, Nationalparkamt, Schlossgarten 1, D-25832 Tönning, Germany, phone +49(0)4861 61647, fax +49(0)4861 61669, e-mail: martin.stock@nationalparkamt.de .

NH: Norbert Hecker, Nationalparkverwaltung, Virchowstr.1, D-26382 Wilhelmshaven, Germany, phone +49(0)4421 911296, fax +49(0)4421 911280, e-mail: norbert.hecker@nlpv-wattenmeer.niedersachsen.de

NPHW Nationalpark Hamburgisches Wattenmeer; c/o Behörde für Stadtentwicklung und Umwelt; Abt. Naturschutz, Stadthausbrücke 8, D-20355 Hamburg, Germany, phone +49(0)40 42840 2169, fax +49(0)40 42840 3552.

PK Peter Körber, Behörde für Stadtentwicklung und Umwelt; Abt. Naturschutz, Stadthausbrücke 8, D-20355 Hamburg, Germany, phone +49(0)40 42840 2169, fax +49(0)40 42840 3552, e-mail: peter.koerber@bsu.hamburg.de.

RG Rudolf Großmann, Südstr. 1, D-26452 Sande, Germany, phone +49(0)4422 9 81 44

RC: Richard Czeck, Nationalparkverwaltung, Virchowstr.1, D-26382 Wilhelmshaven, Germany, phone +49(0)4421 911284, fax +49(0)4421 911280, e-mail: richard.czeck@nlpv-wattenmeer.niedersachsen.de