

Status, threats and conservation of birds in the German Wadden Sea



Technical Report



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Naturschutzbund Deutschland (NABU) e.V.
www.NABU.de

Charitéstraße 3
D-10117 Berlin

Tel. +49 (0)30.28 49 84-0
Fax +49 (0)30.28 49 84-20 00
NABU@NABU.de

Text: Hermann Hötker, Stefan Schrader, Phillip Schwemmer, Nadine Oberdiek, Jan Blew

Language editing: Richard Evans, Solveigh Lass-Evans

Edited by: Stefan Schrader, Melanie Ossenkop

Design: Christine Kuchem (www.ck-grafik-design.de)

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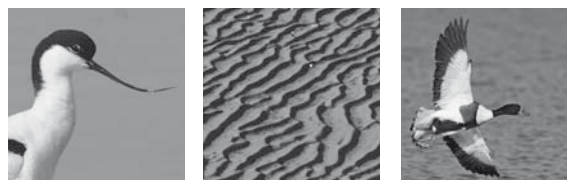


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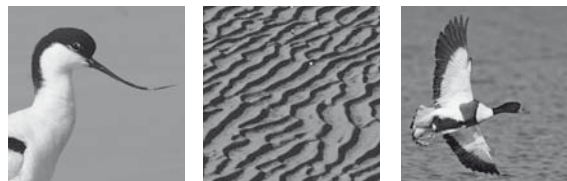
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1. Introduction

The European Wadden Sea, from the Netherlands in the south to Denmark in the north, is one of the world's largest intertidal ecosystems, and one of the most productive coastal areas in the world. Apart from the higher regions of the Alps, the Wadden Sea is the only region in Germany where large-scale natural processes can take place with only little human interference. The Wadden Sea area is unique for the vast extent of its typical natural habitats: mud and sand flats, salt marshes, beaches and dunes. The Wadden Sea is vitally important as a stopover site for birds migrating between their breeding grounds – mostly in the Arctic, from western Canada to central Siberia – and their wintering sites in western Europe and western Africa. These birds use the Wadden Sea to replenish their energy reserves on their long migration. Thus, the Wadden Sea connects large areas of the Arctic to the coasts and wetlands of western Europe and western Africa. Moreover, many birds overwinter in the Wadden Sea, and several species regularly breed there. The Wadden Sea is the single most important wetland in Germany.

Large parts of the German Wadden Sea are protected as National Parks, the highest conservation designation in Germany, but current developments and future threats give cause for concern about the status of the Wadden Sea's birds. Declines of characteristic migratory birds have been reported in the Wadden Sea (Blew et al., 2007; Blew et al., 2005; Stroud et al., 2004). Populations of a number of typical breeding species are also in decline (Hälterlein et al., 2000), Koffijberg et al. 2006). Moreover, the whole ecosystem is threatened by climate change, which may lead to huge loss of habitat due to erosion (Michael Otto Stiftung 2005).

In spite of these threats, and in spite of a number of trilateral publications on birds (Becker & Muñoz-Confuentes 2004, Blew et al. 2005b, Essink et al. 2005, JMMB 2003, Koffijberg et al. 2006, Reineking & Südbeck 2007), there is no up-to-date and comprehensive review of the status, threats and conservation needs of migratory and breeding birds of the German Wadden Sea. This report tries to fill this gap. Specifically it aims to summarize the knowledge of bird populations of the German Wadden Sea,

1. identify the main threats to Wadden Sea birds and their habitats,
2. show the most important gaps in knowledge relating to the protection of birds in the German Wadden Sea, and
3. identify the conservation needs for the birds of the German Wadden Sea.

The report covers the German Wadden Sea and some adjacent areas which are heavily used by Wadden Sea birds. The area covered is the same as the Wadden Sea Area, as defined in Annex 2 of the Esbjerg-II-Declaration (Common Wadden Sea Secretariat, 2002; see Fig. 1, page 11). It includes: the Schleswig-Holstein, Hamburg and Niedersachsen Wadden Sea National Parks; all of the Wadden Sea islands; all Halligen; the offshore waters up to the 3 nm border, plus the Whale Protection Zone off Sylt up to the 12 nm border; all estuaries and all areas reclaimed since 1955; the sea defence walls; and the area between them and the border of the National Park in Schleswig-Holstein.

This report is one of a series of three. Similar reports have been published by the BirdLife partners Vogelbescherming Nederland (VBN) for the Dutch Wadden Sea (Reneerkens et al. 2005) and Dansk Ornitologisk Forening (DOF) for the Danish Wadden Sea (Rasmussen 2007). There is some duplication between the reports because bird species, habitats and threats are similar in all three countries. None of the reports includes detailed descriptions of the birds of the Wadden Sea and their biology. Detailed information on these aspects can be found in more general books such as "Shorebirds" (Kam et al. 2004) or "Handbuch der Vögel Mitteleuropas" (Glutz v. Blotzheim et al. 1966-1997).

2. The German Wadden Sea as habitat for birds

2.1 General description of the German Wadden Sea area

The Wadden Sea is part of the North Sea, a shallow continental shelf sea. The south-eastern part of the North Sea is called the German Bight. Here, the sea floor rises very gently towards the coast. In most places the rise is less than 1m per km. The Wadden Sea borders the German Bight and is an area under the impact of tides. Tidal range is between 2-4m, increasing closer to the shore and upstream within the estuaries.

The Wadden Sea is characterised by vast sandy and muddy tidal flats extending from the mainland out to a chain of islands and sands. The width of this belt of tidal flats generally ranges from 10-15 km, but is as much as 30 km in Nordfriesland in Schleswig-Holstein. The tidal flats are broken by permanently flooded gullies and river outlets. Sediments alternate between sand, which may typically be found in the outer and more exposed areas, and very soft muds in the sheltered estuaries and bays, and on the watersheds between the gullies.

Three large rivers discharge into the Wadden Sea, forming substantial estuaries: the Ems - including the Dollart, a big shallow bay shared between the Netherlands and Germany; the Weser with a relatively narrow estuary; and the Elbe, the largest river discharging into the Wadden Sea. The estuary of the smaller River Eider in Schleswig-Holstein was closed in 1966, but still has a reduced inflow and outflow of salt water. The discharges of all other smaller rivers are controlled by sluices, except for the River Godel on the island of Föhr. There are pronounced salinity gradients along the lower reaches of the Ems, Weser, Elbe and to a lesser extent the Eider. These gradients cause river plume fronts (Krause et al. 1986). Salinity varies strongly in space and time, according to the tides and the river discharges. In the upper reaches of the estuaries, some intertidal tidal flats are mainly influenced by fresh water. The Mühlenberger Loch in Hamburg is the largest site of this type.

As well as the estuaries, some bays cut into the straight coastline. The biggest is the Jadebusen, near Wilhelmshaven. The Dollart - mentioned above - is part of the Ems estuary. The other natural bays along the German

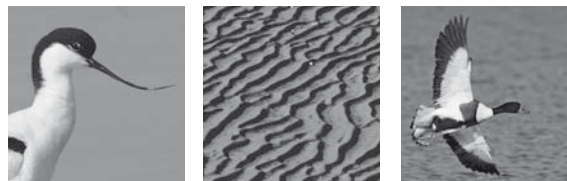
North Sea coastline are the Leybucht in Niedersachsen and the Tümlauer Bucht in Schleswig-Holstein. Artificial bays are formed by causeways built between the mainland and the islands of Nordstrand (1906-1934) and Sylt (1927).

The intertidal flats are partly bordered by salt marshes. Salt marshes form the upper parts of the tidal basin and mark the interface between land and sea. They are strongly influenced by different interactive processes such as tidal regime, sedimentation, soil composition, nutrient load, land use and vegetation succession. Thus, salt marshes have a diverse appearance. Many of the islands, especially in Niedersachsen, have large, naturally developed salt marsh areas. Most of the mainland coast has at least a narrow strip of salt marsh. Here, many salt marshes have been created artificially, by increasing sedimentation rates with the help of brushwood groynes, followed by drainage. The salt marsh belt reaches a width of up to 1.2 km in the Jadebusen (Niedersachsen) and 1.8 km near Friedrichskoog in the outer Elbe Estuary (Schleswig-Holstein). The estuaries have small belts of salt marsh that follow the same salinity gradient as the tidal flats.

The seaward edge of the Wadden Sea is marked by barrier islands and outer sand banks.

These landscape features are found all along the German Wadden Sea coast, and developed in the Holocene, immediately after the last ice-age. Nevertheless, the landscape history and underlying processes of recent centuries vary enormously between the different regions. In Niedersachsen, the coastline is characterised by a chain of barrier islands. These have grown from bare sand banks, and show extensive dunes and beaches. On the mainland, large bays were created by storm surges in the middle ages, when large areas of marsh were eroded. With the exception of the Dollart, all these bays have been re-embanked.

In Nordfriesland, the northern part of the Schleswig-Holstein coast, the whole area that is nowadays covered with tidal flats was once part of the mainland, until the storm surges of the 14th and 17th century. The outer sands mark the former extent of the mainland marshes.



Further east, some of these have developed into barrier islands. Pellworm, Nordstrand and some of the Halligen (marsh islands without dikes) are the remnants of this mainland marsh, while some of the Halligen evolved after the storm surges. The three islands of Amrum, Föhr and Sylt are of Pleistocene origin, but also have younger dunes, beaches and marshes.

The inner part of the German Wadden Sea coast, between the mouths of Weser, Elbe and Eider is characterised by an exposed mainland coast, with only a few, small islands in the Elbe estuary. The large tidal range (2.5 – 3.5 m) means that the dunes of these islands have remained low.

All coastal marshes are protected from flooding by seawalls. Thus, there is a sharp separation between the natural or semi-natural salt marshes, and cultivated land. Most of the area directly bordering the seawall is intensively used as arable land.

Most of the recently reclaimed polders, mainly in Schleswig-Holstein, are now partly or entirely protected and managed as nature reserves: Leybucht (Niedersachsen); Dithmarscher Speicherköge; Eider Estuary; Beltringharder Koog; Ockholmer Westerkoog; Hauke-Haien-Koog; Fahretofter Westerkoog; and Rickelsbüller Koog. Shallow fresh water lakes and wet grasslands are typical habitats in these areas. Salt water habitats in the Beltringharder Koog and the Dithmarscher Speicherkoog are maintained by controlled and reduced inflow of sea water. In the following text, these areas are referred to as conservation polders.

2.2 Landscape history

The Wadden Sea area developed approximately 7500 years ago, following a post-glacial period of rapid sea-level rise. At that time, humans had already settled in the coastal region, which offered rich food resources in the sea and in the highly productive marsh land. The early settlers used the resources of their environment, but they did not greatly influence the natural development of landscape or seascape. Reedbeds, peat bogs and other natural coastal wetlands were found alongside the

belts of salt marsh. Apart from sandy beaches, salt marsh was the universal transition zone habitat between the tidal flats and the freshwater-dominated mainland and islands.

This situation changed in the middle ages, when people started to modify the landscape in order to protect themselves and the land from the influence of the sea. They built dikes and sluices, separated salt marshes from the influence of the tides and created new farmland. Human influence began to dominate the Wadden Sea ecosystem and caused substantial changes in flora and fauna.

Much of the land claimed in the Middle Ages was lost in catastrophic storm tides in the 14th and 17th century, when huge areas along the coast were flooded. The Halligen region developed from former mainland, and large bays developed along the mainland coast of Niedersachsen. Although the large losses of land in the regions of Halligen, Jadebusen and Dollart could never be compensated for, land reclamation continued. As soon as the sediments of the Wadden Sea had formed foreshores and salt marshes that were sufficiently high, these were embanked to gain new farmland. When building new dikes, the number of curves was minimised to reduce maintenance effort. Thus, bays and estuaries were embanked. In front of the new dikes, steps were taken to increase sedimentation rates on the tidal flats. Continuing industrial development and increasing opportunities to mechanise the work allowed more and higher dikes to be built. In this way, nearly all of the natural salt marshes along the mainland coast of the German Wadden Sea have been embanked, whilst modern salt marshes have developed artificially. Over the same period (*i. e.* within the last few centuries), inland wetlands, bogs and fens were also drained. Rivers were regulated and tidal outlets were built. The natural transition zone between salt marsh and freshwater habitats was more or less entirely lost. Active cliffs, the direct contact between the Pleistocene *Geest* (heath-dominated glacial tills) and the sea, vanished from the Wadden Sea landscape, as did spits and gravel fields. Nowadays, the fringe between terrestrial and marine habitats (salt marshes, beaches and island and mainland dunes) has been more or less fixed, in order to protect human settlements.

2.3 Salt marshes: historic development and current management

2.3.1 Extent

Natural salt marshes have been lost due to the large scale of embankment over the past decades and centuries, and shallow bays and bights with slow currents are missing. Thus, natural saltmarsh formation is strongly constrained (Dijkema 1987). Only 40% of recent Wadden Sea salt marshes are of natural origin; these are mainly on the barrier islands (Bakker et al. 1997). The remaining 22,000 hectares are of anthropogenic origin (Esselink 2000) and have to be defended against erosion in most places (Hofstede & Schirmacher 1996, Stock & Kiehl 2000b).

It is still unclear whether the current area of salt marsh reflects a natural size. As salt marshes are anthropogenic in origin, their size reflects the intensity of coastal defence measures (Dieckmann 1988). According to Essink et al. (2005), the total extent is still lower than it would be in a natural ecosystem. On the other hand, Dijkema (1987) considered it impossible to reconstruct the extent of salt marsh prior to 1600 AD, due to inadequate maps. At that time, embankments had already begun to be constructed. Furthermore, he considered it incorrect to derive saltmarsh extent directly from the size of the embanked areas, as the rate of embankment is not directly correlated to the rate of saltmarsh growth. For the period from 1600-1985 AD, he assumed a loss of 80% of saltmarsh due to embankments, with the area in 1860 still being twice as large as in 1985. For Schleswig-Holstein, the situation is slightly different. Here, until the 1920s, obvious embankments were made only when the salt marshes had grown that high that they were almost fresh grasslands (Kolumbe & Christiansen 1961; Raabe 1981). Only since then have tidal flats and salt marshes also been embanked when constructing new dikes. According to Dieckmann (1988) the salt marsh area in Nordfriesland was slightly larger in 1980 than in 1870.

In recent decades, salt marshes have grown greatly in size. In Schleswig-Holstein, the salt marsh area within the national park increased from 5,100 to 6,150 hectares between 1980 and 1988 (Stock et al. 1997) and again to 6,800 ha in 1996 (Stock et al. 2001). Between 1996 and 2001, the total salt marsh area of Schleswig-Holstein increased from 10,010 (van Duin et al. 1999) to 11,440 hectares (Essink et al. 2005). In Niedersachsen, the area of salt marsh increased by 2,400 hectares (1,400 on the

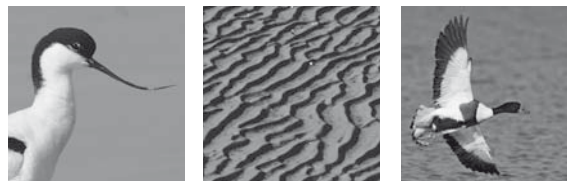
islands, 1,000 on the mainland) between 1966 and 1997 (Bunje & Ringot 2003).

2.3.2 Land use

Human use of the Wadden Sea salt marshes has a long-standing tradition. Grazing by domestic animals was introduced following the first settlement of the coastal region around 2700 – 2300 BP. Miedema (1983 in: Esselink 2000) assumed a grazing intensity during 1900 – 1700 BP (Roman times) of about 1 cattle per hectare. Bakker et al. (1997) assumed that past grazing pressure was so intense, that by around 2000 BP no natural salt marshes remained.

In the decades after World War II, the German Wadden Sea salt marshes were intensively used, especially on the mainland coast. In Schleswig-Holstein, salt marshes are traditionally grazed by sheep. In Niedersachsen, they are traditionally grazed by cattle, but with localised sheep grazing (Harlingerland, Krummhörn) and mowing (Jadebusen).

Salt marsh landuse has been reduced on a large scale since the mid-1980s. At that time, 72% of all Wadden Sea salt marsh was grazed or mown, compared with only 28% unused. There were strong regional differences, as in the Netherlands and Niedersachsen around 50% was not used, compared with just 7% in Schleswig-Holstein (Kempf et al. 1987). Current values for the German Wadden Sea are given in Table 1. Abandonment in Germany was attributable to nature conservation reasons (Stock et al. 1997, Stock & Kiehl 2000b, Wesemüller & Lamp 1987), while in the Netherlands the driver was a lack of farmers' interest (Bakker et al. 1993, Dijkema & Wolff 1983). In recent years, political interest in management has been rekindled. In Niedersachsen, the public bodies responsible for dike maintenance complain about large amounts of strandline material resulting from rank salt marshes in late successional stages. In Schleswig-Holstein, increasing numbers of wintering Barnacle Geese feeding on arable land have prompted the question of whether targeted grazing management could attract them to salt marshes instead.



	Niedersachsen 2003	Hamburg 2002	Schleswig-Holstein 2001/2002
Mown	8	0	0
Intensively grazed	4	37	45
Extensively grazed	18	0	19
Not used	70	63	36

Table 1: Land use of salt marshes in the German Wadden Sea, given as a percentage of total area (Essink et al. 2005).

Extensive research has been carried out on the effects of different land use regimes on vegetation. In summary, intensive grazing strongly reduces the diversity of plant species structure. After abandonment, species diversity and structural richness increase dramatically, but in the medium term (20-40 years), a few species (*Atriplex portulacoides*, *Elymus* sp.), become widely dominant and species diversity decreases. Extensive grazing maintains species numbers and structural diversity, at both large and small scales. Nonetheless, at a landscape scale, species are not vanishing from abandoned salt marshes and the dominance of e.g. *Elymus athericus* depends on local abiotic factors, such as inundation frequency and sedimentation rate. (see Bos et al. 2002 for sandy salt marshes; ESSELINK et al. 2002 for estuarine salt marshes; GETTNER et al. 2000, KIEHL et al. 2000, SCHRÖDER et al. 2002 for foreland salt marshes). Research on the effects of different land use regimes on breeding birds are referred to in chapter 2.4.

2.3.3 Drainage and other coastal defence measures

In contrast to the natural salt marshes of the islands, the existing mainland salt marshes are mostly of anthropogenic origin. They developed in the lee of brushwood groynes and are characterized by a system of artificial drainage ditches. Artificial salt marshes are thus drier and more uniform in relief than natural ones. This alters the zonation of vegetation and reduces diversity (Dijkema & Wolff 1983: 9/194, Esselink 2000: 202).

To allow more natural dynamics within the salt marshes, maintenance of brushwood groynes and the drainage system have been somewhat reduced. In general, all necessary coastal defence measures may be taken, but natural dynamics shall be allowed to operate where coastal defence measures are not necessary. In Schleswig-Holstein, measures are described in a specific coastal-wide management plan (*Vorlandmanagementkonzept*, MLUR

2007). In Niedersachsen, regional management plans are gradually being developed.

2.4 Bird habitats in the Wadden Sea

The Wadden Sea is of outstanding importance both for migratory and for breeding birds. In the course of the year, 10-12 million birds use the European Wadden Sea (Rösner et al. 1995), and up to 2.6 million waders are present in late summer and autumn (Rösner et al. 1999). The Wadden Sea is by far the largest stopover site for birds migrating on the East Atlantic Flyway. In addition, the juxtaposition of extensive feeding grounds and suitable breeding habitat makes the Wadden Sea an internationally important breeding site. Regardless of whether birds use the Wadden Sea for breeding, stopover on migration or for wintering, they depend on the area for two main functions: as a feeding ground and for roosting sites. The following section describes the functions of the different Wadden Sea habitat types in detail.

The nearshore area is the 3 nm zone just off the islands and outer sands. Here, water depths of more than 10 m are dominant and a huge biomass of molluscs is to be found. Coastal areas of the Wadden Sea (especially off the island of Sylt and the Eiderstedt peninsula) where cockles (*Cerastoderma edulis*) and clams (*Spisula subtruncata*) occur in high densities are of great importance for several seabirds. Very large concentrations of Common Scoter (*Melanitta nigra*) and Common Eider (*Somateria mollissima*) occur during winter to feed on this large food resource (Garthe et al. 2007).

The vast area of tidal flats forms the principal feeding ground for waders and for many of the gulls and ducks occurring in the Wadden Sea. Most birds feed on benthic invertebrates. The most important groups are bivalves (e.g. *Mytilus edulis*, *Mya arenaria*, *Cerastoderma edule*, *Scrobicularia plana*, *Macoma balthica*, *Ensis americana*

nus), gastropods (e.g. *Peringia ulvae*), crustaceans (e.g. *Corophium vulotator*, *Crangon crangon*, *Carcinus maenas*) and polychaete worms (e.g. *Arenicola marina*, *Hediste diversicolor*, *Hediste virens*, *Lanice conchilega*, *Nephtys hombergii*, *Scolopos armiger*, *Heteromastus filiformis*, *Pygospio elegans*). The tidal flats vary in their sediment composition and hence in their invertebrate fauna.

Blue mussel beds can be regarded as a special habitat in their own right. Waders and gulls feed on the epibentic fauna of the intertidal mussel beds while Common Eider use both intertidal and subtidal beds for feeding on blue mussels.

Eelgrass beds (*Zostera marina*, *Zostera nana*) and sea lettuce (*Ulva spp.*) are important food sources for Brent Geese (*Branta bernicla*) and Wigeon (*Anas penelope*) in autumn.

The tidal flats are separated by deep inlets which hold water even at low tide and by many more or less temporary tidal creeks which drain the water at low tide. The permanent water bodies support fish (e.g. *Pleuronectes platessa*, *Clupea harengus*, *Pomatoschistus minutus*, *Syngnatus acus*, *Sprattus sprattus*, *Osmerus eperlanus*) and crustaceans (*Crangon crangon*, *Carcinus maenas*) for Cormorants (*Phalacrocorax carbo*), Mergansers, Pied Avocets (*Recurvirostra avosetta*), Spotted Redshanks (*Tringa erythropus*), gulls and terns.

Hard substrate structures in the Wadden Sea are artificial in origin, for example coastal defence measures or harbour piers. These structures are not much used by birds. Generally only gulls, Ruddy Turnstones (*Arenaria interpres*) and Purple Sandpipers (*Calidris maritima*) peck small bivalves or crustaceans from or between the stones, while Common Eider feed on the mussels.

The outer sands and the uninhabited islands are extraordinarily important high tide roosts, while in the breeding season they support mainly terns and gulls.

Dunes, dune slacks and heathlands of the barrier islands are typical breeding habitats for Shelduck (*Tadorna tadorna*), Hen Harrier (*Circus cyaneus*) and Short-eared Owl (*Asio flammeus*). They also hold large colonies of gulls and terns.

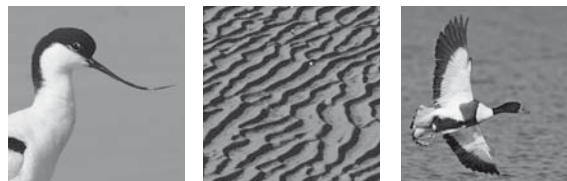
The open, sandy and generally unvegetated beach plains of the islands are used mainly by foraging Sanderling (*Calidris alba*). Kentish Plover (*Charadrius alexandri-*

nus) and Little Tern (*Sterna albifrons*) use the upper parts of beaches as their breeding habitat.

Embanked grassland areas of the islands accommodate important populations of typical meadow birds, such as Black-tailed Godwit (*Limosa limosa*), Lapwing (*Vanellus vanellus*) and Common Redshank (*Tringa totanus*).

The salt marshes of the islands, the Halligen and the mainland coast fulfil many different functions for birds. Migratory birds such as Barnacle Goose (*Branta leucopsis*), Brent Goose and Wigeon forage on salt marshes, to refuel their energy reserves for the next migration step. Salt marshes are the only places in Germany where Horned Larks (*Eremophila alpestris*), Rock Pipits (*Anthus petrosus*), Snow Buntings (*Plectrophenax nivalis*) and Twites (*Carduelis flavirostris*) regularly rest and winter. Shorebirds such as Dunlin (*Calidris alpina*), Bar-tailed Godwit (*Limosa lapponica*), Grey Plover (*Pluvialis squatarola*), Red Knot (*Calidris canutus*), Common Redshank and gulls, all of which feed on the tidal flats, use the salt marshes as high tide roost sites. Salt marshes are of considerable importance as breeding sites for Spoonbill (*Platalea leucorodia*), Oystercatcher (*Haematopus ostralegus*), Ringed Plover (*Charadrius hiaticula*), Redshank, terns, gulls and passerines such as Skylark (*Alauda arvensis*) and Meadow Pipit (*Anthus pratensis*). Mainland salt marshes, notably within the bays, hold large populations of breeding Avocets. Especially in Niedersachsen, older successional stages of the mainland salt marshes provide breeding habitat for Marsh Harrier (*Circus aeruginosus*; regularly) as well as for Hen Harrier (scattered) and Short-eared Owl (scattered).

Research on the effect of salt marsh management on breeding birds revealed some general trends. Abandoned areas have highest species diversity and generally the highest breeding densities. They harbour large numbers of passerines (such as Meadow Pipit, Skylark and Reed Bunting *Emberiza schoeniclus*) and the highest densities of Common Redshank. Raptors (Marsh Harrier, Short-eared Owl, Hen Harrier) and Spoonbill breed in salt marshes only if they are ungrazed. Intensively grazed areas provide better habitat for species preferring short vegetation or bare earth, such as Lapwing, plovers and terns. Nonetheless, their numbers remain low (except from Arctic Tern *Sterna paradisaea*), and passerines are almost absent. The results for extensively grazed areas are inconclusive. Breeding densities are a little higher than in ungrazed areas, species diversity a little lower (for details see Exo & Thyen 2003, Hälterlein 2002, Hälterlein et al. 2003, OLTMANN 2003, SCHRA-



DER 2002, 2003, THYEN & EXO 2003a, b). Drawing conclusions from other grassland habitats, extensively grazed areas might be expected in the long term to support greater diversity of species than abandoned areas, due to their more complex fine-scale vegetation structure. On a larger scale, these differences might be less noticeable, but raptors are still missing from grazed areas.

In recent centuries, embankment of large areas of salt marshes and tidal flats for land reclamation and coastal defence has been widespread. Between 1959 and 1991, embankment continued, but most of these newly created polders have become nature reserves. Partly managed, partly handed over to vegetation succession, the “conservation polders” today are of great importance for breeding birds including meadow birds, waterfowl and reedbed species. They hold the largest proportions of the breeding populations of highly endangered species like Ruff (*Philomachus pugnax*) and Kentish Plover. Moreover, these areas serve as important staging, roosting and feeding sites for migrating geese and waders. In Schleswig-Holstein, the conservation polders form a chain from the Danish border in the north, to Meldorfer Bucht in the south, and provide an insight into how the natural coastal landscape would look if the coastline was not defended and fixed by dikes. However, the conservation polders’ geomorphological dynamics are strongly reduced by the dikes and their water regime is regulated by sluices.

Estuaries are transition zones between marine and riverine environments. There are strong gradients in salinity. Rivers discharge and deposit high load of nutrients. These support bird communities dominated by dabbling ducks (Teal *Anas crecca*, Shoveler *Anas clypeata*) and geese (Greylag *Anser anser* and Barnacle Geese) in the upper parts of the estuaries, and Shelducks and waders in the lower parts of the estuaries. The outer Elbe Estuary is also the most important moulting habitat for Shelducks in North Western Europe, while the salt marshes and other grassland areas enclosing the river mouths are important breeding sites for several wader species, such as Lapwing, Pied Avocet, Common Redshank, Black-tailed Godwit and Gull-billed Tern (*Gelochelidon nilotica*).

3. Conservation Status of the Wadden Sea

3.1 Legal aspects and protected areas

In Germany, political and legislative responsibility for nature protection is principally the responsibility of the governments of the federal states (*Länder*). The Wadden Sea is shared by the federal states of Niedersachsen, Hamburg and Schleswig-Holstein. The state of Bremen includes only a small part of the Weser estuary, just outside the Wadden Sea borders, and will not be considered in this report. Hamburg contains a small part of the Wadden Sea around the islands of Neuwerk, Nigehörn and Scharhörn in the outer Elbe delta. In all three states, the major parts of the Wadden Sea have been declared as National Parks, the highest protected area designation in German nature conservation law.

Although there are many similarities between the regulations (see below) in the three German National Parks, there are some notable differences in the extent of habitats covered. In Niedersachsen, all islands are included in the National Park, with only settlements excluded. An offshore area north of the islands of Borkum and Juist is also part of the National Park. By contrast, in Schleswig-Holstein, the islands (except Trischen) and the large Halligen are all excluded from the National Park. The Schleswig-Holstein Wadden Sea National Park includes an offshore area west of Sylt, the “Whale Reserve”. A 150 m wide strip to seaward of the top of the dike has also been excluded from the National Park area. The Hamburg Wadden Sea National Park covers all of the Wadden Sea within the federal state of Hamburg and includes all of the islands (Neuwerk, Scharhörn and Nigehörn).

Apart from parts of the Ems estuary, the inner parts of the estuaries, together with the large waterways of Ems, Weser and Elbe all fall outside the national park boundaries.

The National Parks are partly complemented by nature reserves. In Schleswig-Holstein these comprise large portions of the conservation polders, most of the Eider estuary, the 150 m strip between the dike and the national park in Nordfriesland and some sites on the islands. In Niedersachsen, nature reserves can be found on the mainland adjacent to the national park in the Leybucht area and near Wilhelmshaven.

The Wadden Sea area has also been included in the European Union’s Natura 2000 network. All three National Parks and all of the conservation polders are classified as Special Protection Areas (SPA) under the EU Birds Directive (in Hamburg since 1982, and in Niedersachsen and Schleswig-Holstein since 1983). These areas are also Special Areas of Conservation (SAC) under the EU Habitats Directive (with the exception of some areas of the conservation polders).

The borders of the different nature conservation areas are shown in Fig. 1.

In addition, the Wadden Sea area is covered by three Biosphere reserves under the UNESCO Man and Biosphere Programme (Schleswig-Holstein 1990; Hamburg 1992; Niedersachsen 1993). Their aim is to innovate, demonstrate and reconcile approaches to conservation of biodiversity and sustainable economic development. The Biosphere reserves boundaries are identical to those of the national parks. In Schleswig-Holstein, the large Halligen (that are excluded from the national park) were incorporated into the biosphere reserve in 2005.

The national parks also fulfil the criteria of a Particularly Sensitive Sea Area (PSSA) under resolution A.720(17) of the International Maritime Organization (IMO). This reflects the status of the Wadden Sea as a defined Special Area under the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78). In these areas, the discharge from ships of garbage and oil is prohibited.

3.2 International conventions

Since 1976, the Wadden Sea is also listed as Wetland of International Importance under the Ramsar Convention of 1971. The mission of the convention is the conservation and wise use of all wetlands world-wide, through local, regional and national actions and international cooperation. Moreover, Ramsar contributes to achieving sustainable development globally. The boundaries of the Ramsar sites as reported to the Ramsar secretariat by the federal states (via the German government) are

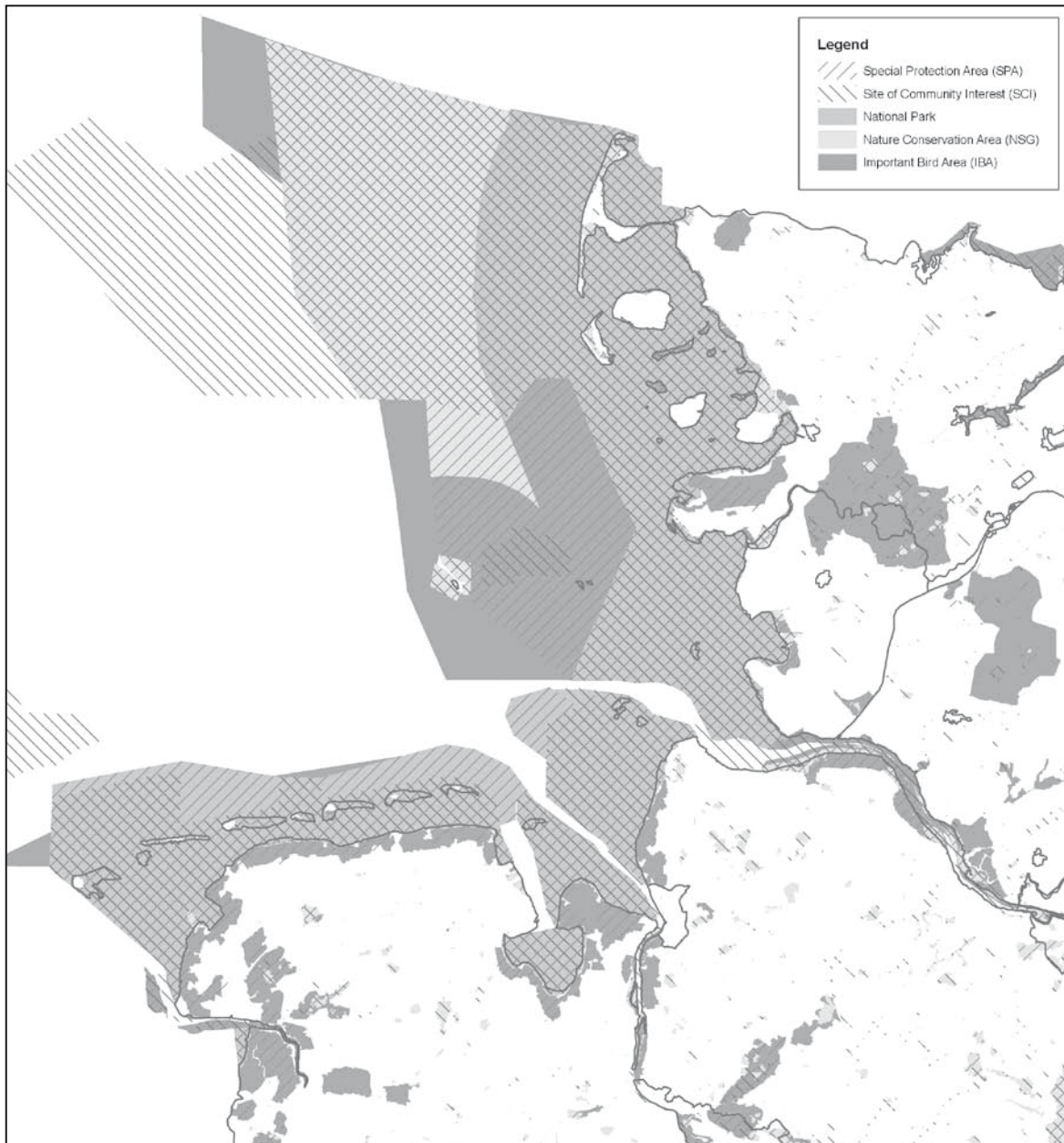
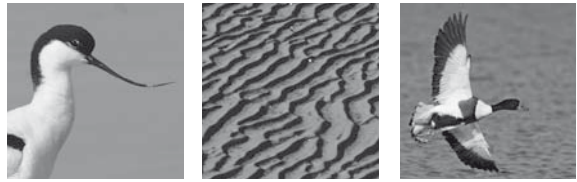


Fig. 1: Different categories of nature conservation area in the extended German Wadden Sea area. IBAs appear grey where they have not yet been designated as conservation areas.

the same as those of the SPAs. Nevertheless, the list and boundaries of Important Bird Areas (IBA) as identified by the NGOs (Wetlands International) show that official site designation is not totally sufficient. (See Fig. 1 for the borders of the IBAs).

The Wadden Sea plays a crucial role in preserving European wildlife, especially migratory species. Relevant measures have to be taken under the Bern *Convention* on the Conservation of European Wildlife and Natural Habitats (1979), and also under the Bonn *Convention* on Migratory Species (also 1979). Both conventions are implemented in law by regulations transposing the EU Birds and Habitats Directives.

The OSPAR Commission is formed by the governments of 15 states bordering the coasts and catchments of the north-east Atlantic. The task of the commission is the protection of the marine environment. Having been mainly engaged in environmental issues as pollution during the first decades of its existence, in 1998 the commission set up a nature conservation strategy. Thus, the protected areas of the Wadden Sea are now part of a network of Marine Protected Areas (MPAs) in the north-east Atlantic region.

In June 2009, the Dutch and the German Wadden Sea (excluding the Hamburg section) were added to the UNESCO World Heritage list. This list comprises the world's most beautiful landscapes, areas and natural monuments that are seen as a common heritage of mankind. Through this endorsement, the member states of UNESCO commit themselves to protect their listed sites for future generations. In the case of the Wadden Sea, UNESCO accepted in principal that the existing conservation rules delivered adequate management. This means that no further regulations will be made as a result of the World Heritage approval (see http://www.waddensea-worldheritage.org/Management_and_Protection.36.0.html). Nevertheless, this status should be seen as a step forward for conservation. Deterioration on a large enough scale could result in the removal of world heritage status and this would probably not be acceptable to the public.

3.3 Administration of the National Parks

The administration of each national park is the responsibility of the relevant federal state. In all of the states, the park authorities are responsible for permit procedu-

res and monitoring. They also employ a number of rangers and operate visitor centres. In Schleswig-Holstein and Hamburg, they are also responsible for promoting ecotourism and educational initiatives.

In Niedersachsen, the national park administration is a discrete unit within the Niedersachsen State Agency for Water Management Coastal Defence and Nature Conservation. It is responsible directly to the Niedersachsen Ministry of Environment and Climate Protection.

The Hamburg National Park administration is part of the Hamburg Authority for Urban Development and Environment.

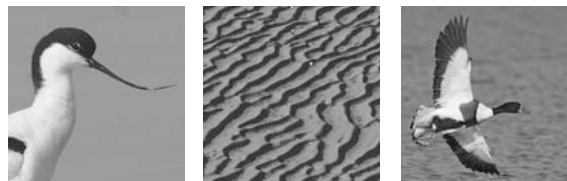
In Schleswig-Holstein, the national park administration is a discrete unit within the Federal State Agency for Coastal Defence National Park and Marine Conservation, which was set up in 2008. It reports to the Schleswig-Holstein Ministry of Agriculture Environment and Rural Areas.

In both Niedersachsen and Schleswig-Holstein, national park boards of trustees have been established. They are staffed with members of authorities and local stakeholders. Their task is to align the development of the national parks with regional interests.

3.4 Main features of the national parks

Each national park in the German Wadden Sea has its own legislation, regulations and administration. Different zones have been established within the national parks, with different levels of protection. The regulations covering the most important activities are detailed in the following sections.

The Niedersachsen Wadden Sea National Park was founded in 1986. It covers an area of about 3,500 km², and it is divided into three protection zones. Zone I (Restricted Zone) comprises 68% of the whole area. It includes the most sensitive parts of the National Park, such as the uninhabited islands of Mellum and Memmert, and has the strictest rules for conservation. The protection of animals, plants and habitats has priority here. Zone II (Intermediate zone) comprises ca. 31% of the park area. Here, there are more exceptions to the conservation regulations. Zone III is also called the Recreation Zone and covers less than 1% of the national park. It includes mainly those parts of the island beaches that are close to



the villages. These areas are available for leisure, recreation and health purposes.

The Hamburg Wadden Sea National Park was established in 1990 and covers an area of 138 km². As in Schleswig-Holstein, there are two different zones. Almost 92% of the National Park is included Zone I, comprising the tidal flats and the uninhabited islands of Nigehörn and Scharhörn. Zone II, 8% of the total area, consists mainly of the inhabited island of Neuwerk.

The Schleswig-Holstein Wadden Sea National Park was founded in 1985 and extends to nearly 4,500 km². Two different zones are set up. Zone I, where some activities are restricted, covers 36% of the park, and includes as its core the uninhabited island of Trischen, the outer sand banks and a small strict nature reserve close to the island of Sylt. The remaining 64% of the national park is covered by Zone II, where more activities are allowed. It includes the Whale Reserve.

3.5 Regulations within national parks

In all three national parks, any activity that leads to destruction, injury, modification or sustainable disturbance of the conservation areas and their elements is prohibited; and public access is partly restricted. However, the detail of national park legislation differs between Niedersachsen, Hamburg and Schleswig-Holstein. Table 2 (page 14) gives an overview on regulations of the most important topics.

To summarise, in Niedersachsen and Schleswig-Holstein, public access to the national parks is quite highly regulated. Salt marsh grazing has been significantly reduced (see chapter 2.3.2). Other economic interests, such as fisheries that can affect the whole intertidal and subtidal area, are regulated only loosely. In Niedersachsen, not even hunting has been banned in principle. Only the Hamburg National Park has relatively strict regulation of economic activities. Shipping-free areas, that might be adequate to protect *e. g.* moulting ducks, have not yet been established in any of the national parks. Shared responsibility for shipping between state and federal government is one of the reasons for this.

3.6 Regulations of coterminous conservation areas

The conservation areas that overlap the national parks are governed by multiple regulations, that cannot be described here in detail. In general, these areas have similar targets to the national parks. However, these are terrestrial areas, with generally higher impact conservation management, such as grazing and water management.

In the Wadden Sea and Hallig Islands of Schleswig-Holstein Biosphere Reserve, there is a special agricultural scheme called the “Halligprogramm”. It is meant to resolve conflicts between cattle grazing and migratory geese on the Halligen. It was initiated in 1987, and its intention is to secure both the income of Hallig farmers and the stop-over sites of migrating Brent and Barnacle Geese.

3.7 Care takers for the Wadden Sea

In all three federal states, rangers of the National Park Service as well as the staff members of regional non-governmental nature conservation organisations are responsible for management and wardening of the protected areas. They carry out the surveys required for monitoring schemes and inform visitors about the National Park and its objectives.

In Niedersachsen, the 14 visitor centres are mainly run by partnerships between the respective municipalities and local NGOs (such as BUND, Mellumrat, NABU *etc.*). The wardening of the national park area is carried out by rangers. These are either employees of the coastal defence agency, or work for the NGOs. Most NGO rangers are either volunteers, or working as an alternative to national service. NGOs receive financial support from the federal state of Niedersachsen for carrying out bird counts and other monitoring activities.

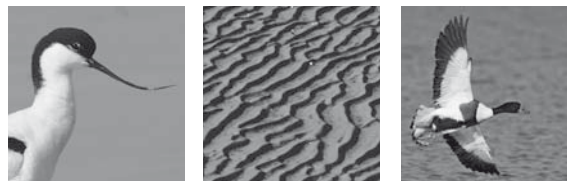
In the Hamburg Wadden Sea National Park, the visitor centre is run as a partnership between the federal state of Hamburg and the Verein Jordsand, a regional NGO. The state employs a ranger, whilst the bird warden on the island of Scharhörn works for the Verein Jordsand.

In Schleswig-Holstein, most of the visitor centres are run by local NGOs (Schutzstation Wattenmeer, Öömrang Ferian, NABU *etc.*), but some others (such as Multimar in Tönning) are run by the National Park Service. The

STATUS, THREATS AND CONSERVATION OF BIRDS IN THE GERMAN WADDEN SEA

Topic	Niedersachsen	Hamburg	Schleswig-Holstein
Park established	1986	1990	1985
Area	3,500 km ²	138 km ²	4,500 km ²
Zonation	Zone 1: 68% Zone 2: 31% Zone 3: <1%	Zone 1: 92% Zone 2: 8%	Zone 1: 36% Zone 2: 64%
Strict nature reserve			1.2 km ² (south of Hindenburgdamm)
Public access	Prohibited in Zone 1 (except on marked paths and on traditional walks) Allowed in Zone 2 (but prohibited in breeding areas from April to July) Allowed in Zone 3 ("recreation zone")	Prohibited in Zone 1 (except on marked paths) Allowed in Zone 2	Prohibited in Zone 1 (but allowed in a 1.000m strip along the coastline); Allowed in Zone 2 (but prohibited in marked areas)
Brown shrimp fisheries	No regulations in principal Prohibited in 10 areas of Zone 1	Prohibited in principal Permitted in navigable, marked waters of Zone 1	No regulations in principal Prohibited in the total reserve south of Hindenburgdamm Voluntary restrictions in Shelduck moulting area from July to September
Blue mussel fisheries	Fishing wild mussel beds for seed mussels: allowed in some subtidal and intertidal areas of Zone 1 no restrictions in Zone 2 Fishing for consumption: allowed in some subtidal areas of Zone 1 no restrictions in Zone 2 Farming: allowed in certain areas of Zone 1 (according to specific management plan) no restrictions in Zone 2	Prohibited	Fishing wild mussel beds: allowed in subtidal areas of zone 1 (by permit) allowed in subtidal areas of Zone 2 (in general) Farming: allowed in subtidal areas of Zone 2 (according to specific management plan)
Cockle fisheries	Prohibited	Prohibited	Prohibited
Oyster fisheries	Use of bycatch from blue mussel fishing allowed	Prohibited	Traditional cultivation lot (size: 30 ha) permitted
Hunting	Prohibited on uninhabited islands and on tidal flats. Allowed in principle in other areas, but hunting waterfowl on the inhabited islands is restricted to 10 days per island per year	Prohibited	Prohibited
Land use	In polder areas, changing the surface relief, ploughing up grassland and pesticide application are all prohibited On the islands, land use may be carried out in the same way as when the national park was established Salt marshes may be mown or grazed according to management plans	Grazing salt marshes in Zone 1 is prohibited in the breeding season, and livestock density is restricted at other times of the year Ploughing up permanent grassland is prohibited	Grazing salt marshes is permitted as far as necessary for coastal defence reasons Grazing areas and densities are specified in management plans Agriculture other than grazing is not allowed within the national park
Gas and oil exploitation	Not allowed	Prohibited	Not allowed, except for exploring and drilling oil from the existing platform Mittelplate A
Shipping	No restrictions	No restrictions	No restrictions

Table 2: Overview of main features and regulations of the German Wadden Sea national parks.



wardening of the national park area is done by rangers. They are either employees of the park administration or work for NGOs. NGO workers are mostly volunteers, or working as an alternative to national service. The number of NGO workers is much greater than the number of state employees. NGOs get substantial financial support from the federal state of Schleswig-Holstein for carrying out bird counts and other monitoring activities.

In all the three states, various aspects of the monitoring schemes are carried out by consultancies or scientific institutes on behalf of the relevant authorities. This is the case for vegetation mapping, some bird counts, seal counts and eelgrass mapping.

3.8 Trilateral Wadden Sea Cooperation

Since the 1970s, the three Wadden Sea countries - the Netherlands, Germany and Denmark - have endeavoured to coordinate monitoring, management, and policies within the Wadden Sea area. The cooperation led to the intergovernmental 'Joint Declaration on the Protection of the Wadden Sea' in 1982. The key element of the trilateral policy and management is the Guideline Principle: "to achieve, as far as possible, a natural and sustainable ecosystem in which natural processes proceed in an undisturbed way". A further objective of the trilateral Cooperation is the implementation of international instruments of nature conservation in the Wadden Sea area. In order to achieve these aims, the Trilateral Wadden Sea Plan (WSP) was adopted at the 8th Trilateral Governmental Conference in Stade in 1997. It contains the common policies, measures, projects and activities of the three Wadden Sea countries for their joint effort to fulfil the ecological targets they declared for the conservation of the Wadden Sea. It is also intended to function as an appropriate management plan for the Natura 2000 sites.

In 1987, the Common Wadden Sea Secretariat (CWSS) was set up as the secretariat for the trilateral Cooperation. It is located in Wilhelmshaven. Its primary task is to support, initiate, facilitate and coordinate the activities of the trilateral Cooperation. The CWSS is responsible for organising the meetings held within the Cooperation framework. It is also responsible for gathering and assessing information regarding the protection of the Wadden Sea; and management and monitoring, including progress in implementing the decisions of the ministerial conferences. In addition, the CWSS collects

information on activities that have, or may have, significant effects on the natural environment of the Wadden Sea and makes suggestions for appropriate actions. Finally, the secretariat coordinates trilateral initiatives in relevant international organizations (Administrative Agreement, 1987).

The work of the secretariat is supervised by a board of representatives comprising one representative from each of the responsible national ministries (<http://www.waddensea-secretariat.org/trilat/structure/CWSS.html#tasks> on 21/09/2009).

Reports and documents produced by the trilateral Cooperation are published by the CWSS. A comprehensive overview of the current status of the ecosystem and the condition of its habitats, the impact of human activities on habitats and species, as well as targets for further management, are all presented in the regularly updated Wadden Sea Quality Status Reports, the next of which is due to be published in 2010.

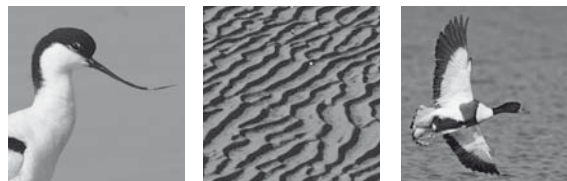
The Trilateral Monitoring and Assessment Program (TMAP) was established to assess the status of implementation of the trilateral targets of the WSP. The TMAP is meant to provide a scientific assessment of the status and development of the Wadden Sea ecosystem. It consists of a set of 24 indicators, including biological, chemical, habitat, human use and other parameters (see <http://www.waddensea-secretariat.org/TMAP/Monitoring.html> for details).

3.9 Monitoring and scientific research of birds in the German Wadden Sea

Monitoring of migratory birds and breeding birds in the German Wadden Sea is carried out within the framework of TMAP (see chapter 3.8). With some differences in methods (roosting birds are counted on spring tides in Schleswig-Holstein, but at weekends in Niedersachsen), huge areas are covered by the counts and the results provide a meaningful picture of population sizes. Results for migratory birds are published with an annual update of trends (Blew et al. 2005a; Günther et al. 2003; Hälterlein et al. 2000). For breeding birds, published and collated information is available only up to 2001 (Koffijberg et al., 2006). In 2009, a "breeding success" parameter is to be included as an indicator in the monitoring activities of TMAP. However, explanations of observed changes in population size of the different species re-

quire specific research, as the monitoring scheme does not include research into underlying factors.

Considerable research has been carried out on birds in the Wadden Sea, particularly in the Netherlands (*e.g.* Beukema & Dekker 2006, Ens et al. 1992, van der Graaf et al. 2002, Piersma 1994), but also in Germany (*e.g.* Becker 1989, Dierschke & Bairlein 2004, Prokosch 1988, Rösner et al. 1995, Thyen & Exo 2003, 2005, Thyen et al. 2008). Several projects were carried out in the 1990s as part of large interdisciplinary research programmes (Umweltbundesamt 2004) that focused on the functioning of the Wadden Sea ecosystem. Once these programmes ended, about fifteen years ago, scientific ornithological work in the German Wadden Sea returned to the species level, focussing on species such as Common Tern, Oystercatcher, Avocet, Redshank, Herring gull. However, co-ordinated research effort on birds in the German Wadden Sea is lacking. Newer research activities and publications, especially on ecosystems level and management-related issues, lack common focus.



4. Issues of concern in the German Wadden Sea

The Wadden Sea area, with its variety of habitats, plants and animals, is threatened by many different types of human activity. Birds that breed or winter in the Wadden Sea area, or stop over on their intercontinental migratory flights, are all vulnerable to impacts on their survival or reproduction. This could be immediate human intrusion that directly affects the survival of birds (e.g. hunting, oil spill), or indirect impacts, such as disturbance at high tide roosts, or disrupting birds from foraging, both of which result in increased energetic costs.

The following chapter describes the main human impacts on the Wadden Sea ecosystem and the consequent threats for birds.

4.1 Habitat change and habitat loss

Chapter 2.2 described the development of the Wadden Sea landscape. In brief, man's influence has changed the landscape dramatically during recent centuries. Although it is still a landscape with large-scale natural dynamics, it is far from being a natural landscape free of human influence.

4.1.1 Missing coastal dynamics

The Wadden Sea is fringed by an intensively used cultural landscape, the existence of which is intrinsically tied to the construction of dikes and other types of coastal defence. Settlement patterns reflect the pattern of land claim and sea defences over recent centuries. Thus, the natural Wadden Sea landscape has been truncated and various features and natural processes are missing:

- The mainland coast is almost entirely fixed by dikes. Recent landscapes lack a natural transition from marine to fresh habitats.
- Barrier islands have sea defences on their western and northern edges to prevent erosion. This fixes the islands in a given position. As a consequence, dune dynamics are severely restricted. Existing dune vegetation reaches older successional stages and dune slacks are overgrown by bushes.

- Erosion of Pleistocene glacial material (*Geest*) has almost ceased, active cliffs have become extremely rare, and gravel beds and spits have vanished from the Wadden Sea landscape.
- Cliff erosion of salt marshes is mostly prevented by coastal defence measures.

This results in a lack of habitat for breeding birds. The loss of open dune landscapes affects Short-Eared Owl, Hen Harrier and Northern Wheatear. Species that breed on beaches, such as Little Tern, Ringed Plover or Kentish Plover, are deprived of fresh gravel beds, islands and spits, that can provide prime predator-free habitat.

4.1.2 Changes in habitat composition

Over the last hundred years, there have been significant changes in the composition of Wadden Sea habitats. This is especially so for the tidal flats.

Oloff (2009) described the vanishing of eelgrass and mussel beds from the western Wadden Sea. These structures are important habitat for other species as algae, crabs, fish and birds. Whilst the loss of mussel beds can be attributed to fisheries, the reasons for the loss of the eelgrass beds are more complex. These include disease, along with reclamation of tidal flats, dredging and seabed-disturbing fishing, all of which prevent recovery. As eelgrass and mussel beds are fundamentally important for nutrient cycles, food webs and species diversity, Oloff considers it possible that the Wadden Sea will never be able to return to its former state, as the changes have been too severe.

Reise et al. (1989, 2008) described the changes in benthic communities in the Königshafen bay on Sylt, by comparing data from 1924 and 1932 with data from 1988 and 1988-2006. They found: a strong expansion of green algal mats on sheltered tidal flats; a decline of red algae in the subtidal; increased abundance of polychaetes inhabiting sandy substrates; a relative increase of sandy substrate and loss of silty substrate; and complex changes and declines in eelgrass beds. The biotic zonation recorded previously has been fragmented. These changes took place on areas of tidal flats that were not directly

affected by human activity, but were influenced by wider environmental change. Increased nutrient loads are likely to have caused the growth of green algal mats. Increased storminess caused substrates to become sandier, benefiting lugworms. Lugworms are in turn thought to benefit mat-forming green algae. The expansion of green algal mats confines eelgrass to ever smaller areas. Like Olf (2009), Reise et al. (2008) consider the changes to be irreversible.

Such changes in the benthic community will of course affect food availability for birds. Although worm-eaters may have benefited, birds that graze on eelgrass beds (such as Brent Goose and Wigeon) have clearly been disadvantaged. Increased patchiness of the benthic biota makes it harder for birds to forage in an energetically efficient way (Kraan et al. 2009).

4.1.3 Reclamation

Large areas have been reclaimed for coastal defence. The largest of these projects in the Wadden Sea was the construction of Afsluitdijk in 1932, which separated the IJsselmeer from the Dutch Wadden Sea and converted roughly 25% of the tidal flats in the whole of the Wadden Sea into permanent shallow waters. In Germany, storm-surge barriers were built at the mouths of the Ems (2002) and the Eider (1973). In the Eider estuary, huge areas of salt marsh were converted to arable land, forestry and wet grassland. Causeways were built in order to change tidal currents, and to improve transport links between the mainland and a number of islands: Sylt, Nordstrand, and the Halligen Nordstrandischmoor, Oland and Langeness. These resulted in profound changes to the geomorphology of the tidal basins, and allowed mammalian ground predators to reach the islands.

Wadden Sea habitats have also been reclaimed for industry. In particular, Niedersachsen has seen huge areas claimed from tidal flats (Emden ca. 2,600 ha; Wilhelmshaven ca. 2,600 ha including the Jade Weser Port), in order to expand industrial and harbour facilities.

In recent decades, land claim has been carried out not only to gain new farmland, but also to improve the drainage of the hinterland. As a result of claiming tidal flats and channels as well as salt marsh, the lower parts of embanked areas can be used as huge impoundments to store inland water. This allows agricultural land to be drained even during periods of high precipitation, when tidal outlets are closed due to high sea water levels. The

large conservation polders in Schleswig-Holstein and the Leybucht in Niedersachsen fulfil this function. These embankment projects have significantly reduced the size of mudflats, and in particular, highly productive silty flats of great value to foraging birds have been lost.

Embankment of tidal flats is most likely to have a positive effect on breeding birds, as new breeding habitat will be created. On the other hand, negative effects on migratory birds are likely, due to possible reductions in food supply. Increased mortality rates due to embankments have been shown in Oystercatchers at the Oosterschelde (Duriez et al. 2009, Schekkermann et al. 1994). Reduced reproductive success was assumed in Siberian Brent Geese that lost their feeding grounds following embankment of the Nordstrander Bucht (Ganter 1997). As many of the migratory bird species under consideration can live for up to 20 years, recent population declines could be in part attributable to long-term effects of large land claim projects in the past.

4.1.4 Settlement

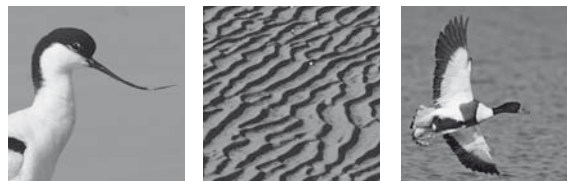
On the islands, housing developments and new leisure facilities (e.g. golf courses, holiday resorts) have caused direct loss of dune, salt marsh, beach and polder habitats, all of which are used by birds for breeding, roosting and foraging. On the sandy islands with high tourist numbers, ground water abstraction has lowered water tables, resulting in degradation of dune slack habitat, and adverse effects on breeding birds such as Short-eared Owl and Hen Harrier.

4.1.5 Waterways

The estuaries of the Wadden Sea have been heavily influenced by dredging, both through increasing the depth of the waterways, and disposal of dredgings. Species diversity and biomass have been adversely affected, both in the subtidal dredged areas, and at the dumping sites, both subtidal and terrestrial. Tidal range and consequently tidal flow have increased dramatically. There are current proposals for further deepening of the Elbe and Weser estuaries. This will cause additional degradation of habitats.

4.1.6 Predation

There is more and more evidence that predation by mammals is becoming an increasing problem for breeding birds in the Wadden Sea (Koffijberg et al. 2006). Small native mammalian predators, such as Hedgehog



(*Erinaceus europaeus*), Black Rat (*Rattus rattus*), Red Fox (*Vulpes vulpes*) and other small mustelids are common on the mainland, and on some islands. Besides invertebrates and other small mammals, these predators also feed on the eggs and chicks of ground-nesting birds, which results in reduced survival of clutches and young, and in increased disturbance of breeding adults during incubation and chick rearing.

Of course, this is not the case in all areas – many of the islands are free from mammalian predators. But the mainland and some islands support large, thriving populations of different predators. Recent studies on some Wadden Sea islands showed considerable impacts of non-native or introduced predators on the breeding success and population levels of breeding birds. On the island of Norderney, ferrets (*Mustela putorius*) were introduced for hunting (BIOS 2008). Some animals escaped and have established a population, which is still increasing - with noticeable effects on local populations of breeding birds. The most striking example of the possible consequences of enabling mammalian predators to reach formerly isolated islands is the disappearance of seabird colonies from the island of Sylt, following construction of the Hindenburgdamm causeway.

Most mainland salt marshes are heavily used by predators from areas behind the seawall (de Boer et al. 2009, Hötker & Segebade 2000, Melter & Vaas 2008, Thyen et al. 2008). Breeding success of birds is often poor. The decline in numbers of Kentish Plover breeding in the salt marshes of St. Peter-Ording seems likely to be due to low breeding success resulting from predation.

Predation pressure has probably increased significantly over recent decades (Langgemach & Bellebaum 2005). A number of factors can be identified for salt marshes:

- Increased diversity of predator species (due to the arrival of new species such as the Raccoon Dog *Nyctereutes procyonoides*).
- Increased predator populations (due to the effectiveness of anti-rabies vaccination).
- Large declines in meadow bird populations behind the seawall, making the salt marshes more attractive foraging areas for predators.
- More cover for predators on the salt marshes in taller vegetation, as a consequence of salt marsh grazing having ceased.

- Finally, changes in landscape structure have had a strong effect on increasing predation rates. Some decades ago, the inland marshes bordering the seawall were flooded for many weeks, or even months, during the winter. Drainage improvements (see chapters 2.2 and 4.1), have greatly lowered water tables in winter and spring, so that these areas are now more or less dry in winter. This makes them more attractive to mammalian predators, and allows easier access to the foreland. Moreover, the inland marshes are increasingly losing their open landscape character, as they become overgrown with scrub and trees that provide cover for predators.

Further research on this topic is needed to better assess the strength of effects on bird breeding success. The TMAP breeding success monitoring intended to start in 2010 might be a first step.

Main threats for birds caused by habitat change and habitat loss

It is clear that a wide variety of habitats has been lost – natural salt marshes on the mainland; active cliffs, spits and gravel fields; and brackish transition habitats. These features are missing from the contemporary landscape, and consequently bird habitats are also absent.

Intensified use of the landscape causes continued degradation of bird habitats, in spite of the high protected area status of the Wadden Sea region.

Predation has been facilitated by these landscape changes, and is likely to have strong negative impacts on breeding bird populations.

4.2 Fisheries

Ever since humans colonised the Wadden Sea area, people have used it as a major food resource. On the islands, fishing was more important than agriculture. Traditionally, fish, brown shrimp and various shellfish species were all exploited.

Nowadays, fish are rarely targeted in the Wadden Sea, due to depleted stocks, in particular flatfish. Flatfish occur as by-catch of the shrimp fishery, but are fished commercially only away from the Wadden Sea. Within the last decade, a Thick-lipped Mullet (*Mugil chelo*) fishery has locally become established.

As fishing has a very long tradition in the Wadden Sea area, there has always been some degree of competition between birds, mammals (seals, harbour porpoises) and fishermen, seeking similar prey. Shellfish, crabs and fish are the basic food resource for many birds in the Wadden Sea, including waders, diving ducks, terns and gulls (Hüppop et al. 1994). The level of competition has probably increased over recent decades, in parallel with intensification of fisheries. On the other hand, especially seabirds may well benefit from fisheries as they feed on discard. Furthermore, the depletion of the stocks of large predator fishes caused a higher availability of smaller fishes well suited as sea bird prey.

4.2.1 Brown shrimp fishery

Although fishing for brown shrimp has a long tradition, it was not until the beginning of the 19th century that technical improvements to ships and onshore infrastructure enabled intensive commercial shrimp fisheries to begin. Fishing for shrimps in the Wadden Sea originally took place only in the tidal creek systems between the islands and the mainland, but today, depending on weather conditions and probably also on consumer demand, it is also carried out offshore of the barrier islands. In economic terms, the brown shrimp fishery is the most important in the Wadden Sea. There is no fishery quota for brown shrimp.

Brown shrimp is one of the most abundant macrofauna species in the Wadden Sea ecosystem, and thus it is an important food resource for many fish and bird species. Shrimps make annual movements between the Wadden Sea and adjacent shallow areas of the North Sea. The Wadden Sea itself is a very important nursery area. The shrimp fishery clearly has a direct effect on the shrimp stock, resulting in a direct negative impact on the next year's stock of shrimp (Neudecker 2001). Furthermore, shrimp fishing affects a range of benthic (bottom-living) organisms. Fine-meshed nets are dragged along the surface of the seabed, effectively ploughing it up. This causes heavy damage to the seabed fauna, and can result in changes to benthic communities. For example, stocks of *Sabellaria* worms are thought to be beyond recovery following heavy fishing impact.

By-catch (e.g. undersized shrimps, juvenile flat fish and non-target benthic invertebrates) accounts for up to 80% of the catch (Walter & Becker 1997). After sorting the catch, non-target species are thrown overboard immediately, but survival rates are low. There is little research on the effects of by-catch and discard on fish

populations in the Wadden Sea, but strong declines in flat fish numbers in the Wadden Sea are probably largely due to the shrimp fishery (Reneerkens et al. 2005). Discarded items are easy prey for gulls and terns. The vast majority of scavenging seabirds following shrimp trawlers are Herring Gulls (*Larus argentatus*) and Black-headed Gulls (*Larus ridibundus*) (Walter & Becker 1997). In some regions, Lesser Black-backed Gull (*Larus fuscus*) has recently become the most numerous scavenging species (Bode 2008). For those species, the intensive exploitation of discards is an important additional food resource which may reduce winter mortality and enhance breeding success. Thus, discards probably have a considerable effect on breeding bird populations in the Wadden Sea. An overview of the shrimp fishery in the German Wadden Sea is given by WWF (2009).

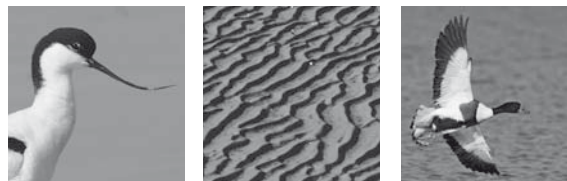
4.2.2 Shellfish fisheries

Fishing for shellfish, mainly Blue Mussel, has intensified since the mid-20th century, when consumer demand increased, and transport and processing conditions were improved. Mussel fisheries are regulated by specific management plans (see chapter 3.5). Commercial fishing for shellfish apart from mussels no longer takes place in the German Wadden Sea.

Cockle fishing ceased in the early 1990s, due to heavy impacts on benthic sediments and organisms from hydraulic dredging. For instance, declines in the number of Red Knot staging in the Dutch Wadden Sea are thought to have resulted from depletion of Knot food resources by an intensified and damaging cockle fishery in the Netherlands (Kaars et al. 2009, Piersma 2007). Similar effects are assumed for other wader species.

Blue Mussel beds occur in both the intertidal and subtidal zones. The ecology of intertidal and subtidal mussel beds is different, both in terms of biogenic bed structure and of associated species communities (Saier 2002). They represent one of the most diverse habitats in the Wadden Sea ecosystem. Natural mussel beds are a relatively reliable food resource for mussel-eating birds like Oystercatcher and Common Eider - and for Curlews, which feed on other invertebrates found in the mussel beds (e.g. Lozàn et al. 1994).

Since the 1950s, mussel farming has been carried on a large scale in both the German and Dutch Wadden Sea, using subtidal bottom cultures (Dankers & Zuidema 1995). The majority of so-called seed mussels (with a shell length of about 1.5 - 3 cm, equivalent to one-year-



old), are dredged from natural wild mussel beds. The seed mussels are then distributed at optimal densities on to culture lots, and are harvested once they have reached a marketable shell size of 4 - 5 cm.

Mussel dredging (for direct human consumption as well for seed mussels) can have considerable negative impacts, by destroying the fauna and flora associated with the mussel beds, as well as through resuspension of bottom sediments which can in some cases cause oxygen depletion (Dolmer et al. 1999). Although only some of the mussels are taken, following dredging the banks are exposed to tidal currents and waves, because of the open uncovered gaps in the mussel beds. Erosion may damage the remaining mussel beds.

Fishing-out of intertidal wild mussel beds can lead to food shortages for mussel-eating birds that rely on this food resource (Umweltbundesamt 2004). Common Eiders are particularly at risk of starvation due to over-exploitation of mussel beds. In contrast, Oystercatchers can switch to other types of food to compensate for periods of mussel shortage (Hulscher et al. 1993).

Heavy over-fishing of intertidal mussel (seed) beds in the early 1990s, in combination with a lack of mussel spat fall, resulted in the disappearance of nearly all of the littoral mussel beds in the Wadden Sea at that time. Since the mid-1980s, the intertidal blue mussel stock in Niedersachsen has lost nearly 95% of natural mussel beds by area and 98% of biomass (Herlyn & Millat 2000). Mussel beds recover very slowly, and new beds can develop only in years with a strong spat fall, which generally occurs only in years following a severe icy winter. Therefore, long spells of mild winters in combination with intensive mussel fishing can have long-lasting consequences for mussel populations. If mussel stocks remain very low over a number of years, an important food resource for several bird species is missing. In particular, Oystercatcher and Common Eider depend on blue mussels, and a lack of this basic food can result in high mortality rates. Tens of thousands of Common Eider starved to death in the severe winters of 1999/2000 and 2001/02, mainly in the Dutch Wadden Sea, due to food shortage (Camphuysen et al. 2002, Stillman et al. 2001).

Common Eiders also feed on farmed mussels. Large, temporary flocks of thousands of ducks can occur in areas with cultivated mussel beds, where they are considered to compete with the mussel fisheries. In the Netherlands, Common Eiders are estimated to consume

60,000t of Blue Mussel biomass annually (Swennen et al. 1989). Studies in the Schleswig-Holstein Wadden Sea showed that Eider and Oystercatcher were not capable of reducing mussel stocks substantially (Nehls 1995). In some cases, Eiders were chased away from farmed beds, which is in effect disturbance of wintering or migrating birds. Just because birds feed on farmed mussels does not mean that there is no food shortage for them: cultivation using seed mussels taken from wild mussel beds enhances neither mussel numbers nor biomass.

Main threats for birds caused by fisheries

Brown shrimp and blue mussel fisheries strongly affect habitat conditions for birds. The main effects are:

- severe disruption to benthic communities resulting in changes to bird food resources
- a decrease in food resources for mussel-feeding birds
- changes in species dominance, as discards provide an additional food resource for some species, mainly gulls.

4.3 Oil and gas extraction

Oil and natural gas exploration and production in the Wadden Sea area began in the 1970s. A wide range of regulations and activities is involved, including seismic surveys, exploration and extraction, as well as drill and pipeline construction.

An oil drilling platform (Mittelplate A) is situated in the area of Mittelplate and Hakensand, south of the island of Trischen in Schleswig-Holstein. It was built in 1985 and is still in service. According to current estimates by the operators, more than 100 million tonnes of crude oil are still to be found, at depths of 2000 - 3000m, of which about 60 million tonnes are considered to be recoverable. The drilling plant is completely surrounded by a sheet pile wall. The oil is transported by pipeline to a terminal on the mainland at Friedrichskoog. The production platform is located within the national park, immediately adjacent to the moulting area of the entire north-west European Shelduck population. So far, there have been no pollution or oil spill incidents. Birds in this area are disturbed by boat traffic, involving both supply vessels and ongoing construction works.

Currently, further exploration for oil fields is planned for the Elbe region of Niedersachsen and Schleswig-Holstein. For this reason, some areas were excluded from the UNESCO World Heritage site. Exploration will probably continue for a number of years, and cause disturbance to birds and marine mammals. If new oil reserves are discovered, it is possible that new drilling platforms could be consented within the national parks.

Natural gas is extracted at two sites, both in Niedersachsen. One is located within the salt marshes of Leybucht in the National Park area, and is still operational. The second is situated within the Dollart area. Production here was stopped in 2000, when the borehole became obstructed. The licence holders are now planning new extraction drillings, as well as seismic surveys for further natural gas deposits within the Wadden Sea in Niedersachsen.

Unlike oil extraction, gas extraction causes soil subsidence. Seabed levels have dropped in the Krummhörn area (Niedersachsen). Subsidence reduces the intertidal area and accelerates erosion processes. It cannot be compensated for. The extent of wader foraging habitat is reduced. Alterations to sedimentation and drift processes may result in the disappearance of outer sand banks, and loss of seal haul-outs and high tide roosts for birds.

The effect of soil subsidence on salt marshes is similar to that of sea level rise. Salt marsh vegetation is impacted by more frequent tidal flooding and increased wave energy (Dijkema 1997). An important characteristic of salt marshes is that they can generally cope with an annual rise in sea level of up to 10 mm, which is within the range of sea level rise under natural conditions. If the rate of subsidence due to gas extraction exceeds this, salt marshes will drown. Vertical erosion and accretional deficits in the pioneer zone in front of the salt marshes are likely (Dijkema 1997). Extensive research on the ecological effects of soil subsidence caused by natural gas extraction is currently being carried out in the area around the Dutch island of Ameland.

On the barrier islands, soil subsidence may have negative impacts on natural reservoirs of fresh water, by lowering the subsoil and thus reducing the amount of freshwater stored.

Main threats for birds caused by oil and gas extraction

Oil and gas extraction should be excluded from national parks and nature reserves. The main threats to birds are:

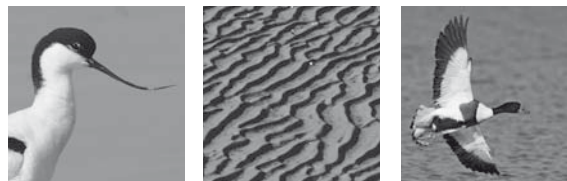
- risk of oil spills (from drilling and pipelines, as well as from shipping vessels)
- direct loss of habitat to infrastructure
- disturbance (noise, light, movements) from plant operation and associated shipping traffic
- subsidence as a consequence of natural gas extraction.

4.4 Tourism and recreational activities

Tourism and recreational activities take place over much of the Wadden Sea area, and can influence landscape, flora and fauna. Detailed data on accommodation, overnight stays and day trips are available for coastal areas of Germany. In all, about 44 million overnight stays are estimated for the combined Niedersachsen and Schleswig-Holstein Wadden Sea area (Essink et al. 2005), indicating a major contribution to the local economy.

A wide range of recreational activities can be found on land and sea, both traditional and new (for example, bathing and kite surfing, respectively). Beaches, tidal flats and waterways are activity „hot spots“. Recreation can lead to considerable disturbance of breeding, roosting and foraging birds in many different ways, and this is true for many land- and sea-based activities in the Wadden Sea area.

Whilst high-tide roosts are generally closed to public access, and thus disturbance is caused only by individual people disregarding the rules, some other conflicts are increasingly important. Current visitor management does not set aside enough undisturbed breeding habitat for beach-breeding species (Little Tern, Kentish Plover, Ringed Plover). Visitor management measures (signs, boards, poles, fences) have been erected in many places, but on beaches they tend to be poorly maintained and ineffective. This can easily be seen on the beaches of Norderney, Spiekeroog, St. Peter-Ording, Amrum and Sylt, inter alia. Fences and signs are in poor condition, and frequently damaged, or missing altogether. Tracks are not marked, and it is not clear where access is al-



lowed and where not. Newly developing primary dunes are excluded from restricted areas. Thus, potential breeding habitat of beach-breeding birds is occupied by tourists, while bird breeding populations have severely declined.

On the other hand, opportunities for observing birds (especially if you are not a birder but a 'normal' tourist) and other wildlife remain poor. There are not many observation towers or hides, and few guided tours aimed at wildlife (bird walks etc.).

Popularity of kite surfing and beach buggies is on the increase, and this affects large areas of beach and adjacent salt marsh. Restrictions need to be put in place, while areas that are not sensitive for wildlife can be designated as appropriate zones for these sports.

Ducks moulting on the water can be affected by recreational boats. They tend to avoid waterways, but this can be further influenced by food supply (mussels). Because "no-traffic" zones shown on navigational charts are fixed, but ecological conditions can change in space and time, traffic restrictions need to be adjusted on a regular basis. In addition, an increasing number of speed boats using the Wadden Sea area disregard speed limits and traffic restrictions.

Main threats for birds caused by recreational activities

Newly popular sports like kite surfing and beach buggies present new nature conservation challenges to ensure that bird habitats in the Wadden Sea remain undisturbed. The largest conflicts between recreational activities and birds are probably:

- general disturbance of beach-breeding birds
- disturbance of high-tide roosts by walkers and kite surfers
- disturbance of moulting ducks by recreational boats and kite surfers

In principle, most conflicts can be resolved by visitor management, but the wardening effort required for this is high.

4.5 Pollution

Marine pollution can be defined as the direct or indirect introduction of toxic substances to the marine and coastal environment, including estuaries, by humans (Kennish 1998). The Wadden Sea is mainly affected by pollution by oil, toxic substances and garbage.

4.5.1 Oil

The only large oil spill in recent years followed the loss of the *MV Pallas* just off Amrum in 1998, and resulted in the loss of large numbers of seabirds (Reineking 1999). But although the effects of large spills can be disastrous for birds and their habitats, most marine oil pollution comes from regular shipping traffic. Some ships deliberately discharge oil in bilge waters, for example when cleaning fuel tanks (sludge), although this is forbidden in principle as the North Sea (including the Wadden Sea) is designated as a Special Area under the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78). Following a decline in the number of reported oil spills during the late 1980s, numbers increased after 1992, but have declined again since 1999 (Essink et al. 2005).

Oil-related seabird mortality is mostly due to chronic oil pollution as opposed to accidents. Seabirds such as divers, grebes, sea ducks, gulls and auks are at risk from oil, as they wander in large numbers widely over the surface of the sea in order to feed, moult and rest. Oil on birds reduces their ability to fly and harms their waterproof plumage. Oiled birds will thus either freeze to death, or starve because they have to preen continuously to remove oil from their feathers. While preening they can ingest oil and may die of poisoning.

Since the mid 1980s, a beached bird survey has been carried out in Germany, according to standardized methods. The proportion of oiled birds out of all dead birds found by the survey can be calculated (the "oil rate"); trends and changes in oil rates are monitored (Camphuysen 1998). Comparison of oil rates between different sea areas has clearly shown that chronic oil pollution is more intense around shipping lanes than elsewhere (Essink et al. 2005).

Beached bird survey results show an overall decline of oil rates within the Wadden Sea and adjoining areas in recent years. Along the North Sea coast of Schleswig-Holstein, the average oil rate for the period since 1999 is 34%. This is significantly lower than the average value in

previous winters. In 2002/03, the lowest value on record (29%) was measured on the island coasts of Niedersachsen (Essink et al. 2005). In general, oil rates are low for the Wadden Sea area inside the chain of barrier islands (Fleet 2006). Despite the marked decline in the Wadden Sea itself (between the mainland coast and islands), oil rates of offshore seabirds, notably Common Guillemots (*Uria aalge*) are still relatively high.

4.5.2 Toxic substances

The Wadden Sea is also affected by pollution from toxic substances including heavy metals, persistent organochlorine compounds, trace elements and xenobiotics (substances that do not originate from biological processes) that originate in agricultural run-off, industrial effluent, or dredging residues. They are mainly transported to the Wadden Sea by the large rivers (Becker & Muñoz Cifuentes 2004). Toxins can accumulate in sediments and in the food web of the Wadden Sea. As most are lipophilic, they accumulate in the tissues and organs of fish and birds. In birds, they also pass into the eggs. High concentrations can impair breeding performance and adult survival. Therefore, bird eggs are useful indicators of pollution, and they may reveal long-term trends in rates of contamination of reproductive females, and hence also the Wadden Sea environment (Becker & Muñoz Cifuentes 2004). That study showed that the Elbe estuary and the inner German Bight remain to have the highest levels of chemical contamination in the Wadden Sea. In the 1990s, contaminant levels in bird eggs were low, and not clearly correlated with reproductive parameters apart from hatching success in Common Gulls (*Larus canus*) breeding in the Elbe estuary (Becker & Muñoz Cifuentes 2004).

Reproduction of birds on the Wadden Sea coasts was not generally impaired by toxic substances during the 1990s (Becker & Muñoz Cifuentes 2004). Other biological effects on seabirds and waders have been recorded only rarely. Concentrations of all major substances have been decreasing from the mid 1990ies onwards. To date, direct mortality of birds appears to have been infrequent, localized and rare. However, in 2008 and 2009, elevated concentrations of dioxin-like substances were found in the livers of foreland-grazing sheep and cattle in both Niedersachsen and Schleswig-Holstein. The reasons are so far unknown.

4.5.3 Garbage

Garbage at sea, especially plastics, remains an unsolved problem. Despite the fact that dumping rubbish is forbidden in principle by the North Sea's status as a Special Area under MARPOL (see chapter 3.1), a huge amount of plastic is floating in the waters of the North Sea. Strandlines cluttered with washed-up plastic are a common sight on beaches and dikes. Pelagic-feeding birds like the Northern Fulmar (*Fulmarus glacialis*) ingest small pieces of rubbish during foraging, as they mistake it for prey. The birds' gizzards fill with indigestible items and the birds starve, as they can no longer digest enough food to meet their energetic requirements. In addition, seabirds may become entangled by rubbish, in particular lost or discarded fishing nets, and this is considered to be a significant cause of mortality. Both the quantity of stranded litter and the number of animal entanglements have increased in recent years, according to OSPAR beach surveys in the Wadden Sea region.

Main threats for birds caused by pollution

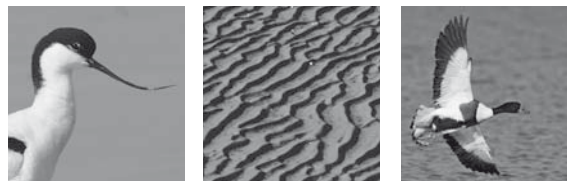
Pollution hazards such as oil spills, spills of other chemicals, or a nuclear accident in one of the five the nuclear power plants in the estuaries of the rivers Elbe and Weser, continue to present real threats. Consequences for birds and the entire ecosystem could be devastating. Even the loss of a relatively small ship, carrying small quantities of oil can have severe effects – demonstrated by the loss of MV Pallas off Amrum in 1998.

4.6 Climate change and sea level rise

Sea levels are expected to rise by up to 56 cm by 2100 (IPCC 2007). Climate change is predicted to be associated with increased temperatures, altered wind conditions and rising sea levels. The possible effects have become a central issue in politics and science. Although climate has always varied, the present situation is characterized by an increased speed of change. This acceleration could induce considerable changes in the Wadden Sea ecosystem.

4.6.1 Coastal squeeze

Normally, tidal flats and salt marshes would move 'upwards', in the sense of an inland shift of sediment depo-



sition relative to a rising sea level. In the Wadden Sea area, this inland shift of tidal flats and particularly salt marshes is constrained, because fixed sea defences obstruct this process. With rising sea level, previously elevated areas of tidal flats will thus convert to lower zones, and the current intertidal flats will become completely inundated (Beukema 2002).

If rates of sedimentation are lower than that of sea level rise, the tidal flats will become less stable, due to storms, which are predicted to become more frequent. This may result in the destruction of natural mussel and eel grass beds that act as sediment catchments and minimize sediment erosion. Salt marsh edges will suffer increased erosion. Upper salt marsh vegetation zones will shift to lower salt marsh zones because of more frequent inundation (Hughes 2004).

These effects of drowning in the coastal transition zone are known collectively as “coastal squeeze”, manifesting itself in reduced extent of tidal flats and salt marsh, and decreased diversity. Birds that depend on particular salt marsh habitats for breeding or foraging may be severely affected (Hughes 2004). Moreover, loss of high-tide roost sites due to more frequent inundation is also likely to have negative effects for shorebirds.

4.6.2 Ecological changes

Loss of intertidal habitat could result in reductions in zoobenthic biomass, or at least in changes to the species composition of the benthic fauna (Beukema 2002). The shift of ‘higher’ lying tidal flats to ‘lower’ lying tidal flats risks impacting fish and shellfish species, for which higher mudflat areas are important nurseries for juveniles. Population-level impacts are possible for these species, and also for shorebirds feeding on fish and benthic flora and fauna (Austin & Rehfish 2003).

In addition to increasing sea levels, climate change has been observed to cause increases in mean air and water temperatures. Since 1980 water temperatures have been increasing in the Wadden Sea (van Aken 2003). As a consequence of the speed of current shifts in climate, cold winters such as 1995/96 seem much less likely to occur in future decades (Parry 2001). In the Wadden Sea, serious negative effects on benthic species diversity, abundance and phenological timing are likely. Population dynamics of common intertidal bivalves, such as cockles, Baltic Tellin, Blue Mussel and Sand Gaper (*Mya arenaria*) are strongly correlated with seawater temperature (Philippart et al. 2003). In north-western Euro-

pean estuaries, severe winters are often followed by high densities of intertidal bivalve recruits (Herlyn & Millat 2000, 2004), while after mild winters larvae densities are usually low. Studies show that rising water temperatures affect the ability of bivalves to recruit, by reducing their reproductive output and by shifting the spat fall period to earlier in spring (Philippart et al. 2003). Prolonged periods of reduced spat fall, and thus lower recruitment, will lead to depletion of stocks of shellfish and shifts in food webs, which can consequently affect shellfish-eating species, including several kinds of shorebird. Alterations to commercial exploitation of shellfish stocks will aggravate this situation.

For migratory birds, the consequences of climate change can be seen in changes in distribution and phenology, relative to rising air temperatures. The distribution of wintering waterfowl in the Wadden Sea is related to winter temperature (Bairlein & Exo 2007). Many more birds remain in northern parts of the Wadden Sea during mild winters compared with cold winters (Meltofte et al. 1994). This means that low December temperatures force the birds to more southerly wintering areas. Thus, warmer temperatures will lead to increased numbers of birds wintering in the Wadden Sea area (Bairlein & Exo 2007). The shift in winter distribution of waterfowl due to higher mid-winter temperatures will also lead to higher numbers as well as increased densities of birds wintering in the Wadden Sea area. Predicted changes in benthos composition (see above) could in theory lead to numbers of shellfish-eating birds exceeding the carrying capacity of the ecosystem. Carrying capacity will have a critical role in terms of density-dependent effects on survival, optimal migration and breeding success (Boyd & Piersma 2001).

Warmer springtime temperatures may cause birds to leave their wintering grounds earlier on migration to their northern breeding grounds. Waders and geese might benefit from a wider time-frame for: breeding; successful chick rearing; clutch replacement in case of nest failure; and attaining body condition for autumn migration (Bairlein & Exo 2007). But, mismatches in timing of breeding are possible if species arrive on their arctic breeding grounds too soon relative to snow melt, food availability (such as insects for chicks) and nutritional quality of food plants (van der Jeugd et al. 2009). The ability to cope with current and future changing environmental conditions depends on the phenotypic plasticity of species, as recently demonstrated for Barnacle Geese (Eichhorn et al. 2008).

Breeding birds will be directly influenced by habitat change and loss through sea level rise (erosion of tidal flats, salt marshes, sand banks, beaches and dunes) and through changes in weather conditions, if floods and bad weather conditions in the breeding season become more severe or frequent (Reineking & Südbeck 2007).

In conclusion, there is still uncertainty over the timing and extent of global warming and sea level rise, and thus also over predictions of impacts on birds of the Wadden Sea.

4.6.3 Coastal defence

In 1999, the Wadden Sea Trilateral Cooperation established an expert group on coastal defence and sea level rise (CPSL), to investigate possible effects of accelerated sea level rise, and to develop proposals for future integrated coastal defence and nature conservation policies. The group consists of members from coastal defence and nature protection authorities of the three Wadden Sea states.

CPSL (2001) developed three scenarios (sea level rise of 10 cm, 25 cm and 50 cm until 2050), and investigated impacts on selected physical, biological and socio-economic parameters. For the scenario of 25 cm sea level rise over the next 50 years (which was considered most realistic), the experts predicted no substantial changes to morphological and biological aspects of the Wadden Sea ecosystem. A sea level rise of 50 cm until 2050 is considered to be the 'worst-case' scenario. The expert group considered that the capacity or even the elasticity of the system to balance changes might become exhausted, and that tidal basins might start to evolve into tidal lagoons. Such morphological changes will have substantial biological impacts. Somewhere between realistic and the 'worst-case' scenarios there will be a threshold of capacity and elasticity in the ecosystem's ability to adapt to the changes expected to result from loss of tidal flats. That threshold varies strongly among the tidal basins.

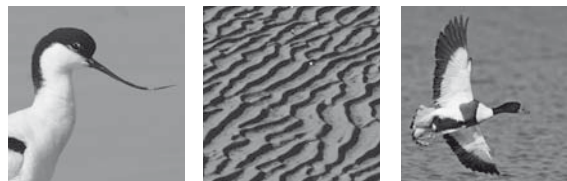
Based upon the description of the natural system, the expert group of CPSL investigated instruments and measures which might contribute to sustainable coastal defence strategies for the Wadden Sea, and recommended: spatial planning and establishment of coastal regional plans including buffer zones and coastal flood hazard zones; sand nourishment to successfully counteract coastal erosion; dune management to ensure the

functionality of dunes as natural flood defences; salt marsh management aiming at maintaining the flood defence function of marshes; promotion of natural mussel and eel grass beds to encourage accumulation and stabilization of tidal flats; disembankment of summer polders to reduce the height of storm surges upstream; and sea dike measures (CPSL 2005). Finally, the CPSL group formulated recommendations:

- The establishment of coastal spatial plans based on the principles of integrated coastal zone management.
- The application of sand nourishment to counteract erosion along sandy shores, as well as a concomitant study on feasibility and effects of sand nourishment to balance the sediment deficit of tidal basins and rising water level.
- The establishment of regional salt marsh management plans, to harmonize the demands of coastal defence and nature conservation.
- An evaluation of the feasibility and ecological consequences of maintaining the present safety standards.

Ecological impacts of future coastal defence measures remain uncertain, but such measures could trigger demand for large-scale excavation of sand in the Wadden Sea. The ecological consequences for the benthic fauna will be set out in project-level environmental impact assessments (regeneration mostly within a few years, depending on the speed of sedimentation and compaction). However, effects on ducks, in particular Common Eider and Common Scoter, are much more difficult to estimate and identify. Knowledge on feeding ecology of the birds is still insufficient, and information on distribution of their food and on possible food limits for the wintering populations are all lacking. Research is needed in order to be able to estimate the impacts on these birds, and to develop species management plans. A preliminary evaluation of current and future sand extraction has been carried out by BioConsult SH (2008). This study showed that sand extraction would probably cause a loss of scoter feeding habitat. It is thus proposed to plan future excavations outside the Wadden Sea area, as Common Scoter prefers water depths of 16m or less.

On the other hand, sand replenishment might prevent large scale habitat loss from erosion, and coastal defence measures could possibly be combined with habitat protection or creation (Reise 2003).



Main threats for birds from climate change

Climate change manifests itself as a gradual factor affecting the whole ecosystem, including all species groups, natural processes and ecological interactions (habitats, birds, benthic fauna, and also with humans and human activities).

Changes to habitats on arctic breeding grounds or in southern wintering areas, and shifts in food resources due to changing temperatures or other environmental factors, will have indirect effects on Wadden Sea bird populations.

In addition, there will be direct effects on Wadden Sea bird habitats, due to sea level rise (erosion of mudflats, salt marshes, sand banks, beaches and dunes), and possibly also to increased frequency and severity of floods and bad weather conditions during the breeding season.

Enforced coastal defence measures will also affect habitats.

4.7 Introduced Species

Originally, the Wadden Sea was a relatively species-poor ecosystem, but it is being forced to accommodate increasing numbers of non-native species, often introduced from Pacific regions. To date, about 52 non-native species have been recorded in the Wadden Sea. Non-native algae and invertebrates came by ship (ballast water) or via aquaculture, and have become established mostly on hard substrates such as mussel beds, or within estuaries. Once exotic marine species have become established, there is hardly any way to eliminate or to control their numbers or distribution without harming other parts of the ecosystem. This results in a complete mixture of native and non-native biota from similar climate and biogeographical regions from all over the world. It is assumed that many of these introduced species have only minor impacts on the native biota, but some species can potentially become highly abundant, alter habitats, or displace native species.

One familiar invasive plant species is the Japanese Rose (*Rosa rugosa*). This salt-tolerant plant originates in eastern Asia and was introduced into the Wadden Sea area in the 1930s. During World War II, it was used to camouflage bunkers, and more recently it has been planted to fix dunes for coastal defence. The species has an enormous capacity to spread, in particular into slightly eutrophic open sandy dune patches. It has spread rapidly,

and currently it dominates large areas of dune, forming dense impenetrable thickets. It outcompetes native dune vegetation and causes a considerable loss of natural open dune grasslands. Hen Harrier, among other species, is affected through loss of suitable breeding habitat.

The most prominent invasive animal species is the Pacific Oyster (*Crassostrea gigas*). Its recent spread is surely the most spectacular biological invasion in the Wadden Sea ecosystem. The Pacific Oyster was first imported to western Europe, including the Wadden Sea, in 1964. A thriving culture using spat taken from Britain was established on the island of Sylt in 1986. Once in the Wadden Sea, spread occurred naturally by larval drift and possibly also by transport of young oysters attached to ships' hulls. Whilst it took the Sylt population until the 1990s to leave their tidal basin north of the Hindenburgdamm, the western Dutch population began to spread eastwards a little earlier. In recent years, the Pacific Oyster has spread throughout the entire Wadden Sea, accompanied by rapid development from solitary oysters to coherent reefs. The extent of negative effects of Pacific Oyster on Blue Mussel stocks in the Wadden Sea is not yet fully clear. Oyster reefs are observed to overgrow intertidal mussel beds and they compete with naturally occurring species of shellfish for phytoplankton as food. Nevertheless, some studies have revealed the possible coexistence of both bivalve species (Diedrich 2005). For mussel-feeding birds, significant changes in food supply will occur if Blue Mussel beds are overgrown by oysters. Oystercatcher and Herring Gulls seem clearly able to adapt to this new habitat and feed on the associated fauna, such as worms and shore crabs, and learn how to handle at least the smaller oysters. This will not be the case for Common Eider, as they swallow their prey complete with shells; for them the spread of the Pacific Oyster is probably unfavourable (Nehls & Büttger 2007). In 2009, the first large-scale die-off of the Pacific Oyster was registered, mainly in the Dutch and Niedersachsen section of the Wadden Sea. It is not yet known whether this could indicate the onset of a population regulating mechanism, possibly by a parasite.

Main threats for birds caused by introduced species

Introduced species may become a threat to the ecosystem if they are strongly invasive in character. The spread of species such as *Rosa rugosa* (Japanese Rose) and *Crassostrea gigas* (Pacific Oyster) shows how such species are able to cause a loss of good quality bird habitat.

4.8 Eutrophication

Eutrophication is defined as the enrichment of water by nutrients and organic matter, causing an accelerated growth of algae and higher forms of plant life. This results in undesirably large biomass (algal blooms), followed by oxygen deficiencies and impaired water quality. Artificial eutrophication caused by human activities is also known as nutrient pollution.

Eutrophication causes an increase of primary production. As a consequence, elevated levels of plankton biomass, microphytobenthic algae and macrophytobenthic algae occur. This is followed by a growth of animal primary consumers. In particular, numbers of small polychaetes increase. Among the macrozoobenthic species, substrate feeders increased considerably compared with filter feeders. Eutrophication thus indirectly causes changes in species dominance and composition.

Further effects of eutrophication are blooms of phytoplankton and macroalgae (e.g. *Ulva*, *Enteromorpha*), followed by mass release of toxins ('red tides') or oxygen depletion. An expansion of anoxic soil conditions to the surface of tidal flats can be attributed to eutrophication. Anoxic conditions result in contamination, and mass mortality of fish or other organisms requiring aerobic conditions (polychaetes, shellfish). Anoxic conditions on intertidal flats may also render any remaining invertebrates unpalatable to birds.

Therefore, soil and water nutrient levels can have a substantial effect on habitat conditions in the Wadden Sea. Nutrients arrive in the Wadden Sea from the air as well as from the rivers that discharge into the Wadden Sea. Measurements of nutrient levels in sea water show a significant increase over the last 50 years. Following improvements to wastewater treatment, especially in urban areas, the main sources are now traffic and intensive agriculture (e.g. due to excessive application of fertilizers and slurry). Following measures taken to reduce riverine nutrient loads in the 1980s, the concentrations of phosphorous and nitrogenic substances are slowly but steadily decreasing (Beusekom et al. 2008).

Decreasing nitrogen concentrations have already changed habitat conditions. Loebl et al. (2008) show that the growth of phytoplankton in the Wadden Sea is increasingly limited by nitrogen, and those authors conclude that reduced phytoplankton biomass leads to lower growth rates of suspension feeders, and of species feeding on benthic deposits. This in turn affects shore-

birds feeding on the benthos. As benthic and pelagic nitrogen turnover is higher than phytoplankton production, additional nitrogen from the North Sea is needed to maintain production at recent levels (Baird et al. 2004 in: Loebl et al. 2008).

It is difficult to predict the significance of decreasing nutrient loads for benthic-feeding birds. Lozán et al. (1994) point out that the increased biomass of benthic fauna resulting from eutrophication was not exploited by consumers such as crustaceans, fish and waders. Only gull populations appeared to be positively influenced by the increased food supply due to eutrophication. On the other hand, decreasing biomass of benthic deposit- and suspension-feeders such as worms is likely to affect foraging waders. It has recently been shown that tidal flats are used to their carrying capacity by foraging migratory birds (Kraan et al. 2009). Olf (2009 – chapter 4.1.2 above) argues that seagrass beds once played a much more prominent role in the food web of the Wadden Sea, but having now been so severely depleted it is possible that they may never fulfil the same role again. So, if benthic biomass within the Wadden Sea ecosystem is now declining as a consequence of decreasing external nutrient loads, and if internal alternative biomass production (eelgrass beds) does not take its place, the amount of food available for higher trophic levels (fish, birds) will also decrease, leading in turn to depleted fish stocks and reduced numbers of foraging birds.

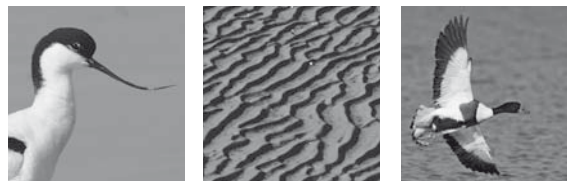
Main threats for birds caused by eutrophication

Severe eutrophication may result in toxic conditions due to algal blooms, with negative effects on habitat conditions.

On the other hand, eutrophication of recent decades is likely to have strongly altered species dominance and composition of the Wadden Sea ecosystem. It is uncertain, how the system will react to decreasing levels of nutrients.

4.9 Hunting

Hunting in the Wadden Sea has a long tradition and taking of seals and trapping of waterbirds (mainly ducks, geese and waders) were once an integral part of the livelihood of the inhabitants of the islands and coastal areas. Nowadays hunting has become more and more of a recreational activity. Hunting in the Wadden Sea



is not completely forbidden (see Table 2), but it is more intensive in the marsh areas on the mainland side of the sea wall. Seals are no longer hunted in the Wadden Sea and the hunting season was closed in 1973 in Niedersachsen, and in Schleswig-Holstein in 1974.

Wildfowling is one of the most significant sources of disturbance during the migration and wintering seasons (Madsen & Fox 1995). Geese, ducks and swans are particularly sensitive. As well as direct mortality of birds through shooting, hunting can have indirect effects in terms of temporal disruption of natural activities of birds (e.g. feeding), alteration of their daily rhythms and increased flush distances. Hunting can displace birds from their preferred feeding and roosting habitats at both local and regional scales, as well as increasing turnover rates, with the result that the carrying capacity of a site may not be reached (Madsen & Fox 1995). This means that birds have less time to forage, incur increased flight costs and sometimes are forced to feed or roost in less suitable areas, which in turn results in reduced food intake rates and increased energy expenditure. As a result, birds may suffer from starvation. Fitness decreases and mortality rates increase, and so hunting can have a considerable effect at a population level (Reneerkens et al. 2007). Furthermore, hunting can cause disruption of pair bonds and family structures, which may in turn affect reproductive output (Madsen & Fox 1995). Studies in Denmark showed that geese that wintered in undisturbed areas had better reproductive success than those using disturbed sites (Madsen 1995).

In recent years, illegal bird hunting is known to have occurred at a number of sites. This includes hunting during closed periods, and hunting species that are not legal quarry (geese, raptors, raven).

Hunting for species other than birds is not a serious problem from a conservation perspective, and the taking of mammalian predators may even be slightly beneficial for breeding birds (see chapter 4.1.6).

Main threats for birds caused by hunting

Hunting causes severe disturbance for birds, and may in turn negatively influence reproductive success.

Protected species may suffer from hunting if they are misidentified for quarry species (e. g. Lesser White-fronted Goose *Anser erythropus*).

Illegal hunting seems to have become an increasing problem in recent years.

4.10 Wind farms

It is European Commission policy that by 2020 renewable energy will contribute 20% of total primary energy demand in Europe. In Germany, the government has set a target of about 30% renewables by 2020. In this context, it is proposed that offshore wind farms will contribute up to 50% of all renewable energy. The Wadden Sea area will thus be faced with three developments: more onshore wind farms; the replacement of existing turbines by larger ones; and the construction of offshore wind farms.

Although the Wadden Sea Conservation area itself is not affected by plans for offshore wind farms, there are still potential impacts for birds. In particular, these are the risk of collision, barrier effects and disturbance (habitat loss).

Collision with rotor blades, towers or nacelles can lead to direct mortality or lethal injury of birds (Drewitt & Langston 2006). At onshore wind farms, the risk of collision is generally considered to be low, with exceptions at migratory “bottlenecks” such as the Strait of Gibraltar (Exo et al. 2003). Nonetheless, some species (notably Red Kite *Milvus milvus* and White-tailed Eagle *Haliaeetus albicilla*) might be at greater risk of collision simply due to their hunting behaviour. Collision risk with offshore turbines might be greater, because these are taller and rotor blades are longer, resulting in considerably higher speeds at the blade tips, and greater air turbulence. Every year, millions of birds cross the North Sea on migration, en route to stop-over or wintering sites, or their breeding sites in the Arctic. Collision risk is greatest at night, especially on moonless nights or in unfavourable weather conditions such as fog, strong wind and rain-fall (Exo et al. 2003). Although there are considerable differences in flight altitudes between different species groups (van der Winden et al. 1999, Krüger & Garthe 2001), studies have shown that only a small proportion of birds crossing the sea on migration fly at the same height as the rotor blades when they would be in danger of colliding with wind turbines (Exo et al. 2003).

Wind farms can act as barriers to bird movement, both on migration routes and within ecological units. Some species, including geese, forage on grassland behind the main sea wall, but roost on adjacent salt marsh or tidal flats within their stop-over or wintering sites. Wind farms located close to the dike can cause a barrier effect, deterring birds in their daily movements to and from high-tide roosts, in turn leading to displacement of roo-

sting and/or foraging birds from certain areas around the turbines. On migration, birds often avoid wind farms completely. Several observations indicate a reaction of geese, ducks, waders, gulls and terns to the presence of turbines at distances of a few hundred metres, with birds trying to fly higher or change flight direction (Desholm & Kahlert 2005). Flock formation can be disrupted as a consequence of flight adjustments to avoid collision (Exo et al. 2003). In general, any avoidance reaction of birds to prevent collision will result in higher flight energy expenditure, which could in turn affect the condition of birds. Larger migratory species seemed to be more affected by wind farm barrier effects than local residents, which seem to be able to adapt to the presence of wind farms within their activity range.

Disturbance is generally relatively low for resident birds. For breeding birds, there was a tendency for waders nesting on open ground to be displaced by wind turbines by up to 100m, according to meta-analysis by Hötker et al. (2006). For non-breeding birds, Lapwing may be displaced by wind turbines by up to 400m (Reichenbach & Steinborn 2006). Studies have shown no negative effects on local numbers, distribution or foraging behaviour of wintering Common Eider and Common Scoter in areas off the Wadden Sea coast (Guillemette et al. 1999). According to a species-specific vulnerability index for seabirds (Garthe & Hüppop 2004), Black-throated Diver (*Gavia arctica*) and Red-throated Diver (*G. stellata*) are most sensitive, followed by Velvet Scoter (*Melanitta fusca*), Sandwich Tern and Great Cormorant, whereas the Black-headed Gull (amongst others) was least sensitive. The extent and intensity of the disturbance of birds by wind farms thus depend on site- and species-specific factors.

Main threats for birds caused by wind farms

Ecologically adverse effects of wind farms on birds include barrier effects and collision. The construction of wind farms may also strongly affect the wide and open character of the landscape.

These effects may be dealt with successfully by spatial planning (maintaining flight corridors), careful site selection (avoiding highly sensitive areas) and by technical measures (shutting down turbines on migration days to prevent collisions). Ostfriesland offers an example of the negative effects of lacking spatial planning.

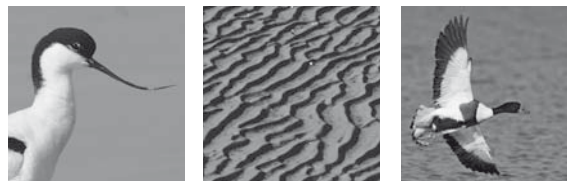
4.11 Military activities

Military activities in the Wadden Sea area include: exercise areas and firing ranges for ground forces and aircraft; testing areas for military equipment; low altitude flying areas; air target areas for military aircraft; and associated aircraft and helicopter flights. The focus of military activities is situated in the western Dutch part of the Wadden Sea.

In Germany, there is one military area within the Wadden Sea National Park of Schleswig-Holstein. The German Ministry of Defence has a testing site for new weapons systems and missiles at the Meldorfer Bucht in the outer Elbe estuary. It extends to around 12,000 ha, of which 10,000 ha are within the zone I of the Schleswig-Holstein Wadden Sea National Park. Projectiles are launched from the mainland or from the Helmsand peninsula at virtual targets on the tidal flats. They are recovered from the Wadden Sea by helicopter, or by search parties at low tide. The number of test days has been reduced to between 10 and 20 days per year. Tests are mostly carried out between November and the end of March. No tests are undertaken from mid-June to mid-September, which is the main moulting time for Shelduck (Essink et al. 2005).

Other military activities include air and other traffic associated with the use of the exercise areas. In Germany, there are several military airports (Jever, Wittmund, Nordholz, Eggebeck/Tarp, Kropp) in the vicinity of the Wadden Sea area. Due to its conservation status as a national park, military aircraft are required to keep to minimum flight altitudes of 3,000 feet (915 m) for jet aircraft and 2,000 feet (610 m) for other aircraft including helicopters - unless specific operations are conducted, or severe weather conditions force to do otherwise. Some areas (Leybucht, Außenweser, Jade - including the Jadebusen) are part of a low altitude flying area, with a minimum flight height of 500 feet (152 m).

With regard to the impact of military activities within the German Wadden Sea, a study on quantifying possible effects of missile tests on birds in the Meldorfer Bucht was carried out during one launch. The study showed relatively small effects on birds feeding on the adjacent tidal flats (Smit & de Jong 2002). During the launch itself, the birds on the tidal flats showed no strong reactions such as panic flights. Birds, mainly ducks, that were present in the salt marshes close to the launch site reacted by flying up only for a few minutes, probably due to the sound of the launch. The most si-



gnificant disturbance of birds is caused by preliminary low altitude range-clearing helicopter flights, and by collecting missile remains following firing, which also involves helicopters, or people walking on the tidal flats. Smit & de Jong (2002) observed that birds disturbed by a helicopter flying at 1,000-1,100 feet over the tidal flats remained in the air for 1-2 minutes. Impacts of helicopter flights on birds foraging on the tidal flats are difficult to predict or quantify, as they will depend on the number of birds present, time of year and other conditions. Compared with other types of disturbance due to human activity within the Wadden Sea area (see previous chapter), disturbance by military activities in the Meldorfer Bucht area is considered to have relatively minor effects on breeding, foraging or roosting birds.

Main threats for birds caused by military activities

Military activities may in general cause huge disturbances for birds.

As most military training areas in the German Wadden Sea have been closed down, the remaining effects are relatively minor.

Nonetheless, considerable disturbance is regularly caused by low-altitude training flights.

5. Species accounts

5.1 Population trends

Population trends for both migratory and breeding birds vary between different parts of the East Atlantic Flyway and it is not fully known where on the flyway the root causes of these trends for different species originate. It could even be the case that enhanced conservation measures elsewhere on the flyway are behind decreasing bird numbers in the Wadden Sea (Madsen 2007). For example, the number of Curlew wintering in Denmark increased significantly after hunting them was banned (Laursen 2005). But there is no doubt that some problems and negative influences on bird populations arise in the Wadden Sea itself (Davidson 2003).

5.1.1 Migratory birds

Population trends for 33 migratory shorebird species are provided by the Joint Monitoring Group for Migratory Birds (JMJB), within the framework of the Trilateral Monitoring and Assessment Programme (TMAP). The data shown refers to the time period 1986/87 - 2006/07. Annual updates are available on the website of the Common Wadden Sea Secretariat. Most of the species considered showed at least moderate declines (see Fig. 2).

Data analysis reveals different population trends for different species. In summary, 4 of the 33 species under consideration increased, and 9 were stable. Nineteen species (~ 58%) decreased, at least moderately (see Fig. 2). No trend could be calculated for Common Eider.

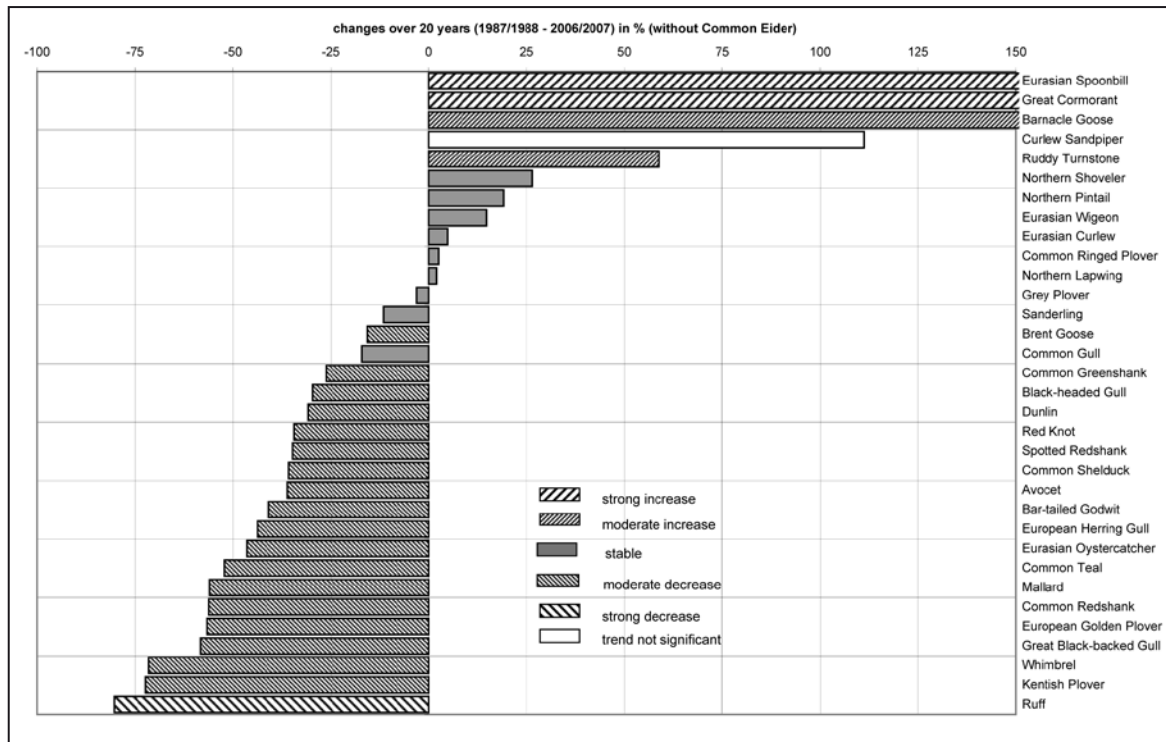
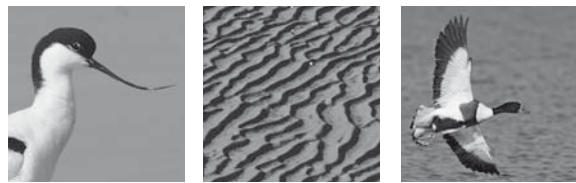


Fig. 2: Overview on population trends of migratory bird species within the 20-year period 1987/88 – 2006/07 in the German Wadden Sea. Data provided by JMJB.



Species showing a strongly positive non-breeding population trend within the German Wadden Sea are Great Cormorant, European Spoonbill and Barnacle Goose. For the first two species at least, this is probably due to an increasing breeding population in the Wadden Sea. As a result, more birds stay in the Wadden Sea after breeding and before departing for their wintering grounds. Ruff showed a strongly decreasing population trend. Moderately decreasing trends were found for Kentish Plover, Whimbrel and other waders, ducks and gulls. Many of the trends cannot be explained, due to gaps in knowledge of species ecology, population dynamics and habitat conditions within their breeding, stop-over and wintering sites.

Comparing the 20-year trend with the 10-year trend shows that some species have done slightly better during the last 10 years compared with the whole period. Pintail and Curlew “improved” from being stable to increasing. Brent Goose, Common Shelduck, Red Knot and Common Redshank trends “improved” from moderately decreasing to stable. All species that declined in the later 10-year period also showed declines declining for the longer 20-year period.

5.1.2 Breeding birds

Within in the TMAP, 33 breeding bird species are regularly censused in the German Wadden Sea. For 21 out of these 33 species, the Wadden Sea holds more than 1% of the total north-western European breeding population. Data are analysed by the Joint Monitoring Group for Breeding Birds (JMBB). The latest population data available are from 2006. Trends are available for the pe-

Fig. 3 is the same as Fig. 2, but only for the 10 year period from 1997/98 - 2006/07. Within this period, 4 species increased, 11 were stable and 15 declined. Common Eider is included.

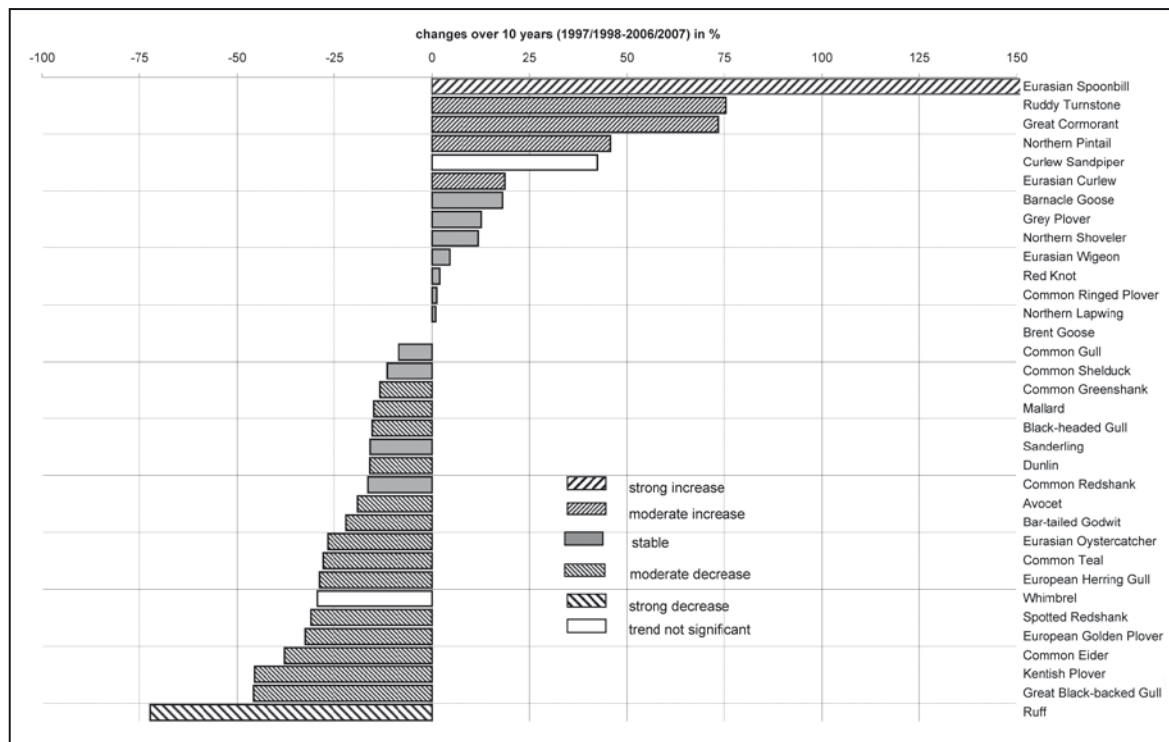


Fig. 3: Overview on population trends of migratory bird species within the 10-year period 1997/98 – 2006/07 in the German Wadden Sea. Data provided by JMBB.

STATUS, THREATS AND CONSERVATION OF BIRDS IN THE GERMAN WADDEN SEA

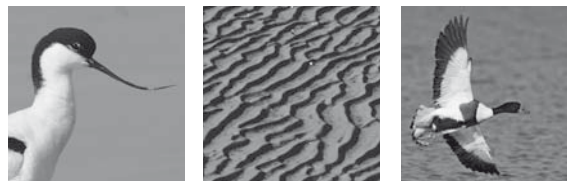
riod 1991-2001, and an update based on data up to 2006 will be made available on the website of the Wadden Sea Secretariat.

Although there are regional differences, the overall trends for several species are consistent across the Wadden Sea, suggesting that large-scale factors are influencing population levels. From 1991 until 2001, these

trends included significant population increases for 10 out of the 31 species. Most notable are the very high rates of increase for Cormorant, Spoonbill and several gull species. The strongest declines were shown by nine species, mostly waders, including Great Ringed Plover, Kentish Plover and Oystercatcher, as well as Herring Gull and Black-headed Gull.

Species	Schleswig-Holstein	Niedersachsen	total	remarks
Great Cormorant	549	840	1389	
Eurasian Spoonbill	35	150	185	
Barnacle Goose	207	0	207	
Shelduck	1790	2901	4691	
Eurasian Wigeon	34	0	34	
Pintail	24	0	24	
Common Eider	228	984	1212	
Red-breasted Merganser	26	1	27	
Hen Harrier	4	43	47	
Oystercatcher	10331	9865	20196	
Pied Avocet	4428	2035	6463	
Great Ringed Plover	282	181	463	
Kentish Plover	180	18	198	
Northern Lapwing	4566	2265	6831	
Dunlin	0	0	0	
Ruff	12	1	13	
Black-tailed Godwit	608	737	1345	
Eurasian Curlew	6	114	120	
Common Snipe	24	28	52	
Common Redshank	4060	4610	8670	
Turnstone	1	0	1	
Black-headed Gull	20805	24624	45429	
Common Gull	2872	6796	9668	
Mediterranean Gull	8	152	160	
Herring Gull	10111	17533	27644	
Lesser Black-backed Gull	13421	23451	36872	
Great Black-backed Gull	13	2	15	Niedersachsen data from 2005
Gull-billed Tern	39	6	45	
Sandwich Tern	2300	2934	5234	
Arctic Tern	2862	730	3592	
Common Tern	3168	3049	6217	
Little Tern	248	169	417	

Table 3: Breeding populations (breeding pairs) of 33 breeding bird species in the German Wadden Sea in 2006. Data provided by JMBB.



Possible causes of the observed trends are not known in detail for all species, but could be associated with management policies, e.g. shellfish fishery. Furthermore, the dramatic downward trends of Great Ringed Plover and Kentish Plover are associated with intense human disturbance in their beach breeding habitats, combined with a lack of habitat dynamics. Increased risk of predation seems to affect Avocet and Black-headed Gull in particular, and this is assumed to be the driving force behind displacement of colonies from mainland breeding sites to the islands, where mammalian predators are usually absent (Koffijberg et al. 2006).

5.2 Species description

The following chapter introduces those 51 species that are regularly present in the German Wadden Sea with 1% of their total flyway population or that are in Germany restricted to the Wadden Sea. Species accounts include a general description of the function of the Wadden Sea in the life cycle of each species, their conservation status, knowledge gaps and possible conservation actions.

Great Cormorant *Phalacrocorax carbo*

Status: breeding, passage/wintering

Global breeding range and populations

There are six subspecies of Great Cormorant, which is found on all continents except South America. The world population is estimated at 1.37 – 2.94 million individuals, 380,000 – 405,000 of which occur in north and central Europe (Delany & Scott 2006). Two subspecies breed in Europe: (1) *Phalacrocorax carbo carbo* occurs primarily in coastal regions in north and west Europe; and (2) *P. c. sinensis* which is distributed from the Netherlands over the whole Wadden Sea as far as Scandinavia and the Baltic States (Bauer et al. 2005a). Both subspecies combined account for 310,000 – 370,000 pairs in Europe (BirdLife International 2004).

Breeding population size in the German Wadden Sea, distribution and trend

Numbers of breeding Cormorants in north-west Europe have increased rapidly for several decades. Possible reasons for this trend are better protection from direct persecution, and increased food supply as a consequence of eutrophication (e.g. Kiekbusch & Knief 2007). In most countries, population growth has tended to level off.

The same holds true for many colonies on the German Baltic Sea, whereas the breeding capacity of the German Wadden Sea has clearly not yet been reached (Berndt et al. 2003). Cormorants started breeding in the German Wadden Sea on artificial structures and islands in the Ems and Weser estuaries around 1970. At first, all German colonies were in Niedersachsen. Breeding in Schleswig-Holstein began in 1997, on the island of Trischen. In recent years, Cormorants have spread out to several new colonies, all located on islands. In 2001 the breeding population of the German Wadden Sea was approximately 1,030 pairs (Koffijberg et al. 2006). In 2006 there were 1,389 pairs (Table 3); 840 in Niedersachsen and 549 in Schleswig-Holstein. In Niedersachsen, the largest colonies can be found on Memmert, Lütje Hörn, and Knechtsand (Heckenroth & Laske 1997). In Schleswig-Holstein, there are colonies on the islands of Trischen, Föhr and Sylt.

Phenology in the German Wadden Sea, distribution and trends

Cormorants can be found in the Wadden Sea all year round. Numbers peak in August and September and are lowest during the winter months (for further details see Koffijberg et al. 2003; Blew et al. 2005). However, as a consequence of milder winters, many Cormorants (at least in the Danish Wadden Sea; Bønløkke et al. 2006) have extended their wintering areas northwards, leading to higher wintering numbers in the German Wadden Sea. The increase of the total north-west European breeding population has resulted in an increase in the number of Cormorants counted in the Wadden Sea, both in Niedersachsen and in Schleswig-Holstein. Due to their high susceptibility to disturbance, the largest roosts are found on undisturbed islands such as Mellum, Nigehörn and Trischen. In addition, many birds roost on anthropogenic structures in the offshore area.

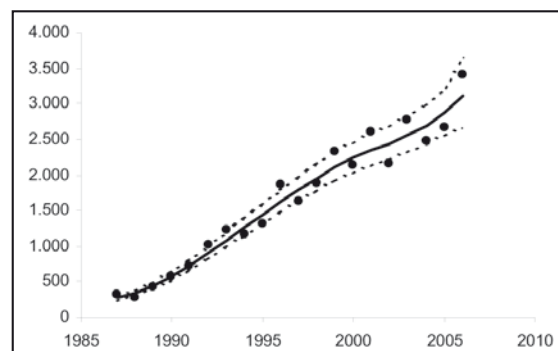


Fig. 4: Population trend of the Great Cormorant in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

As Cormorants may possibly cause damage to fisheries, persecution of Cormorants (both legal and illegal) has started again in parts of Germany away from the Wadden Sea. It is not known how the disturbance of breeding colonies and culling of Cormorants at other sites during the non-breeding season will affect the Cormorant populations of the Wadden Sea. In this context, there is a need to assess exchange rates of breeding birds between the Wadden Sea coast and inland sites. Presently, there is little knowledge about the effects of disturbance in foraging habitats, e.g. by ships, fisheries or tourism. Effects of climate change on locations of breeding sites, breeding success and population trends should also be considered.

Conservation actions

Strict protection of Cormorants in the Wadden Sea should continue, in order to buffer population losses due to Cormorant management elsewhere. Scientific results of research into the foraging ecology of this species should be promoted to a wider public, in order to point out the complex relationships between Cormorants and their (natural) prey, because at least in natural systems the possible influence of Cormorants on fish species suited for human consumption remains open to question (e.g. Mädlow 2007).

Eurasian Spoonbill *Platalea leucorodia*

Status: breeding, passage

Global breeding range and populations

Three geographically separated subspecies of Eurasian Spoonbills are recognised, breeding in Eurasia, Mauritania and at the Red Sea. The global population is estimated at 65,500 - 142,500 individuals, 11,300 of which are found in coastal west Europe (Delany & Scott 2006). The subspecies breeding in Europe is *Platalea leucorodia leucorodia*. Its breeding distribution is widespread but patchy, and suffered a serious decline between 1970 and 1990; currently the European breeding population holds 8,900 - 15,000 breeding pairs (BirdLife International 2004).

Breeding population size in the German Wadden Sea, distribution and trends

The Wadden Sea holds about 65% of all Spoonbills breeding in north-west Europe. While breeding numbers in south-eastern Europe have decreased dramatically in recent years as a consequence of persecution and drai-

nage (Bauer 2005), the population trend in the Wadden Sea is still upwards (Koffijberg et al. 2006). Colonisation of Germany by Spoonbills followed a long population increase in the Netherlands, and did not start until 1995, when the first breeding attempt was recorded on Memmert. In 1996, Spoonbills bred successfully for the first time on Memmert and Mellum (Heckenroth & Laske 1997). In 2000, the first colony in Schleswig-Holstein became established on the Hallig of Oland (Boschert 2005). Spoonbill colonies are found only on islands and Halligen in Niedersachsen (at present 6 colonies) and Schleswig-Holstein (at present 3 colonies). In 2006, the breeding population of Niedersachsen consisted of 150 pairs, with the largest colonies located on Memmert (70 pairs) and Mellum (34 pairs; Südbeck unpubl. data). In Schleswig-Holstein, in 2008 a total of 58 pairs bred on the Hallig of Oland (37 pairs), Trischen (19 pairs) and Föhr (2 pairs since 2007) (K. Günther pers. comm.). There are many signs that the breeding range of Spoonbills is currently expanding northwards.

Phenology in the German Wadden Sea, distribution and trends

Spoonbills can be found in the German Wadden Sea during the breeding season and in summer, when numbers peak in August and September, while from March to October hardly any Spoonbills are found in the Wadden Sea at all (for further details see Blew et al. 2005). Numbers recorded on regular counts have increased strongly in recent years (Fig. 5), reflecting the increased breeding population. Important resting sites for Spoonbills are located in coastal wetland sites within conservation polders such as the Hauke-Haien-Koog and the Meldorfer Speicherkoog in Schleswig-Holstein, or the Leyhörn, as well as clay pits behind the sea dyke in the Jadebusen area in Niedersachsen.

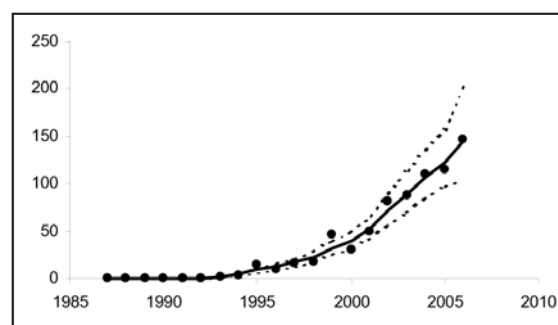
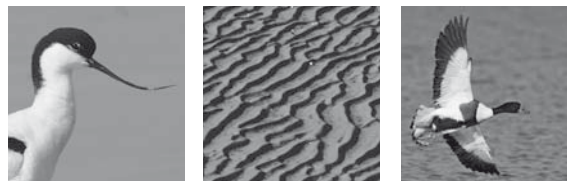


Fig. 5: Population trend of the Eurasian Spoonbill in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.



Gaps in knowledge

At present, not enough is known about exchange rates between different breeding colonies. A ringing programme has been initiated to unravel this issue, and this should be continued. Little is currently known about the foraging ecology of this species in the German Wadden Sea, and therefore also about potential interactions with suitable prey. This issue, as well as commuting movements between breeding and foraging sites should be studied further, in order to permit early identification of possible threats to this rare breeding bird. Spatial and temporal patterns of winter movements of Spoonbills breeding in the German Wadden Sea are inadequately known.

Conservation actions

The highly clustered breeding distribution of this species on islands, as well as regular predation by foxes in the Netherlands, indicate a high vulnerability to mammalian predators. In this context, the colony on the Hallig of Oland is threatened by the fact that foxes may colonise the Hallig following the recent construction of a new causeway between it and the mainland. As Spoonbills have only just started to resettle in the German Wadden Sea, the high level of legal protection given to their breeding colonies should be maintained.

Barnacle Goose *Branta leucopsis*

Status: breeding, passage/wintering

Global breeding range and populations

Barnacle Geese breed in three distinct populations located in eastern Greenland, Svalbard and north-west Siberia (mainly around the Barents Sea). Some birds breed as far south as the southern North Sea. The European breeding population is estimated at 41,000 – 54,000 pairs (BirdLife International 2004). Traditionally, central Europe was only used for wintering, but recently, 2,200-2,800 pairs have been recorded breeding there. This is the only breeding site for this species in temperate regions anywhere in the world. These birds should be considered as a fourth population (Bauer et al. 2005). The world population of the Barnacle Goose is about 503,000 birds; the breeding population of North Russia and the east Baltic, of which a large proportion winters in the Wadden Sea, consists of 420,000 individuals (Delany & Scott 2006). During the non-breeding season almost all of the Barents Sea population can be found at sites across the Wadden Sea. Arctic breeding populations have been increasing for several decades (for details see Zöckler 2007).

Breeding population size in the German Wadden Sea, distribution and trends

The breeding range of Barnacle Goose in northern Europe has expanded hugely. Following the first breeding attempt on the mainland of Schleswig-Holstein in 1988 (Berndt et al. 2003), Barnacle Geese started breeding in the German Wadden Sea region in the Dithmarscher Speicherkoog in 1991 (for details see Hälterlein 1998). At the same time, there was a strong increase in the number of non-breeding birds staying over the summer (Berndt & Busche 1991). Since the 1990s, the breeding population in the German Wadden Sea has increased almost exponentially. All of the colonies are in polders, where the geese typically nest on small islands within abandoned clay pits (for more details see Koffijberg et al. 2006). At present, most of the breeding birds of the Wadden Sea are located in Schleswig-Holstein (c.200 pairs in 2006), where highest numbers are found in the Rickelsbüller Koog and the Beltringharder Koog (Hälterlein, unpubl. data). In Niedersachsen, including the Unterelbe region, only a few breeding attempts have been recorded in recent years. Regular records have been made from the island of Wangerooge, but this small population is kept rather like domestic animals, fed by people year round. However, numbers on this island are no more than 6 breeding pairs (Mellumrat unpubl. data).

Phenology in the German Wadden Sea, distribution and trends

Nearly all of the Barents Sea population can be found during the non-breeding season at sites around the whole Wadden Sea, many of them in Germany. Barnacle Geese occur in high numbers around estuaries, as well as in and close to conservation polders. They forage on salt marsh and farmland, mainly grassland and to a lesser extent arable crops (Koffijberg & Günther 2005). Mainland foraging sites are usually found close to undisturbed roosting sites (Goethe et al. 1985). Thus, areas adjacent to the Wadden Sea fulfil an important function as foraging and roosting habitats. The majority of migratory birds arrive in the German Wadden Sea in late September or early October. Numbers of wintering Barnacle Geese depend on the severity of the winter. In spring, peak numbers occur in April. In recent years, the departure of geese for the breeding sites has been delayed by several weeks - in particular in Schleswig-Holstein, where now tens of thousands of Barnacle Geese regularly stay until mid-May (Koffijberg & Günther 2005). In recent years the number of birds staying over the summer has increased steadily. High numbers of non-breeders occur in areas where breeding colonies have already been established. Numbers of roosting

Barnacle Geese have increased strongly over the whole German Wadden Sea area, reflecting range expansion and the shifting phenological patterns of this species.

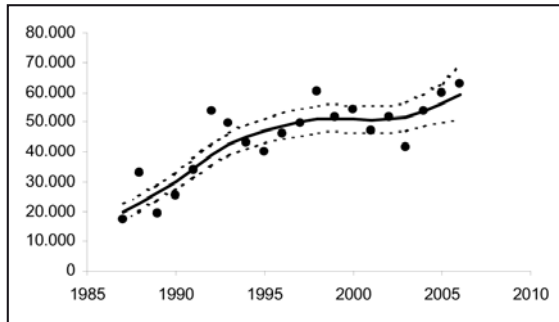


Fig. 6: Population trend of the Barnacle Goose in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

The reasons for the expansion of breeding range, the increase in numbers and the delay in spring migration are all poorly understood. Further detailed analyses of habitat utilisation patterns in the German Wadden Sea, and studies of migration behaviour may help to gain further insight into important spatial and temporal changes over recent years. Moreover, better understanding of habitat utilisation would be an important basis for mitigating conflicts with stakeholders. In this context, more information on regional commuting patterns (from resting to foraging sites) between the Wadden Sea and the adjacent farmland sites should be gathered.

Conservation actions

Numbers of Barnacle Geese have increased and, most importantly, many Barnacle Geese now stay until mid-May. In particular, long-staying geese cause damage to arable and grass crops. In many areas outside the national parks, farmers are allowed to scare the geese from their fields, using automatic gas canons. Limited shooting on arable fields is also permitted. Shooting and scaring both cause disturbance to the geese, and also to other non-target species (Lapwing, Black Tern). Shooting may increase the flush distance of the geese. Increased shyness of geese could lead to more conflicts between recreation and nature conservation, and to a loss of feeding habitat for the geese, as areas frequented by the public would be avoided by the geese. Agricultural damage caused by geese should not be dealt with by shooting, but by other means. The payment of compensation, or adequately tailored agri-environment schemes should be favoured, and could be combined with measures to attract geese to particular areas.

Brent Goose *Branta bernicla*

Status: passage

Global breeding range and populations

There are three different subspecies: (1) *Branta bernicla bernicla* breeding in western Siberia, (2) *B. b. nigricans* in the western Canadian Arctic and (3) *B. b. hrota* in Svalbard and north Greenland. The global population is about 564,000 birds, with c.200,000 individuals occurring in western Siberia, of which a large proportion winters in the Wadden Sea (Delany & Scott 2006). In Europe, this species breeds in Arctic regions and has a small population consisting of approximately 1,000 – 2,300 pairs (BirdLife International 2004). In contrast, the winter population in Europe is considerably larger, consisting of more than 240,000 individuals. Since 1995, the Siberian breeding population has shown significant declines (Zöckler 2007).

Phenology in the German Wadden Sea, distribution and trends

Nearly the entire population of the Dark-bellied Brent Goose can be found at sites across the Wadden Sea in May, just before departure for the breeding grounds. Brent Geese return from late September onwards. After a peak in October, numbers fall again with only a few birds wintering in the Wadden Sea, most of them in the Dutch part. Spring migration starts again in March, and in May between 70 and 100% of the West Siberian population can be found in the Wadden Sea (for details see Koffijberg & Günther 2005).

In autumn, just after arrival, Brent Geese first feed on *Zostera* and algae beds on the tidal flats, turning to salt marshes once the food on the flats has been depleted. Although Brent Geese can be found on many salt marshes both in autumn and spring, the Nordfriesland Hallogen hold the biggest share of the German population. Inland habitats are less important for foraging in Germany than they are for Barnacle Geese.

The Wadden Sea population has followed the trend of the world population. Having previously been very abundant, the population crashed in the 1940s, but then recovered, following the introduction of fairly strict protection and reduced hunting pressure. In recent years, however, a significant decrease has been recorded. The reasons for the decline are not fully understood, but it has been accompanied by a reduction in breeding success. The majority (c. 80%) of Brent Geese in the German Wadden Sea stay in Schleswig-Holstein. Here, the decreasing trend of recent years has been particularly strong (Blew et al. 2005b).

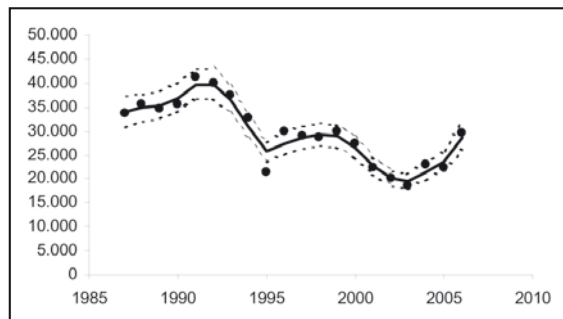
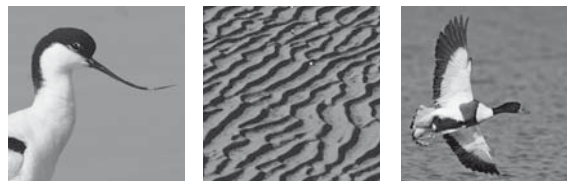


Fig. 7: Population trend of the Brent Goose in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

The reasons for the decline in numbers are not yet understood. It would be desirable to know whether the decline can be confidently attributed to poor productivity on the breeding grounds, in which case problems in the Wadden Sea during migration and/or winter could be excluded as potential factors (other processes such as competition with Barnacle Goose have already been discussed; Engelmoer et al. 2001). Analyses of habitat utilisation patterns in the German Wadden Sea may help to gain further insight into the important spatial and temporal changes of recent years. Reasons for the phenological shift in the Wadden Sea have so far remained unclear.

Conservation actions

After having been regarded as a pest species by farmers on the Halligen, the species' image has improved greatly in recent years. Specific agri-environment schemes (*Halligprogramm*) have ensured fair compensation for damage caused by the geese, and the Brent Goose has been discovered as a specific tourist attraction ("Brent Goose Days" on the Halligen).

Conservation actions to stop the population decline must be preceded by research aimed at unravelling the reasons for the low breeding success.

Greylag Goose *Anser anser*

Status: breeding, passage/wintering

Global breeding range and populations

Greylag Geese has two subspecies, *Anser anser anser* breeding in north-western Europe and Iceland, as well as Scandinavia, and *A. a. rubrirostris* breeding from

south-western Europe to Asia. Both subspecies intermix in central Europe (Bauer et al. 2005). Their European breeding population consists of 120,000 – 190,000 pairs (BirdLife International 2004), and it is strongly increasing. The proportion of non-breeding individuals all over Europe is very high. The global population is approximately 1– 1.1 million birds, with c.500,000 birds occurring in north-western Europe (Delany & Scott 2006). Greylag Geese showed a strong decline, at least in central Europe, in the course of the 19th century, probably due to intense persecution and habitat destruction. However, in the 20th century the European population started to increase – partly because of released captive birds and improved conditions on the breeding grounds (Bauer et al. 2005).

Breeding population size in the German Wadden Sea, distribution and trends

The central European breeding population of Greylag Geese started to increase in the first half of the 20th century and more strongly in the 1950s and 1960s (Berndt & Busche 1991). Likewise, the numbers of breeding Greylag Geese in the German Wadden Sea area have also increased strongly. In Schleswig-Holstein, several birds were introduced in the 1970s to the island of Amrum and to the Hauke-Haien-Koog, where they started breeding. Since then, breeding has occurred in the conservation polders and on the islands, and has spread out to salt marshes and the Halligen (for details see Bernd & Busche 1991; Hälterlein 1998). Families of geese from the Halligen often walk or swim over the tidal flats in order to feed on freshwater grasslands next to the mainland dyke. As in Schleswig-Holstein, most breeding colonies in Niedersachsen were established by reintroduction. In the 1980s, the first breeding attempts in the Niedersachsen Wadden Sea occurred on the island of Borkum (Heckenroth & Laske 1997). Since then, this species has spread out over a much wider area in the Wadden Sea. The breeding population in the Schleswig-Holstein Wadden Sea area in 2006 was around 1,120 individuals, with most colonies being located on coastal wetlands and a smaller proportion on islands such as Amrum and Sylt (Hälterlein, unpubl. data). In Niedersachsen, 257 pairs bred in 2006, with the highest numbers on Langeoog and Borkum (Staatliche Vogelschutzwarte im NLWKN, unpubl. data). Typically, a high proportion of non-breeders can be found in the summer close to breeding colonies (Bauer et al. 2005).

Phenology in the German Wadden Sea, distribution and trends

In parallel to the increase in their breeding population,

numbers of Greylag Geese counted at high tide counts have increased as well. Some of this increase is undoubtedly due to increased numbers of breeding birds; however, as with the Barnacle Goose, there seems to be a steady increase in the number of non-breeders as well. The Wadden Sea area also holds many moulting Greylag Geese. Obviously, many geese migrate to places like the Hauke-Haien-Koog to moult there. In the Wadden Sea region, the highest number of birds occurs during the autumn migration (particularly in October), while there is a much smaller peak of birds during the spring migration (Goethe et al. 1985, Berndt & Busche 1991). The most important stop-over sites are the Elbe estuary, the Leybucht, and reclaimed polders such as the Hauke-Haien-Koog, Beltringharder Koog and Dithmarscher Speicherkoog. In recent years, the number of overwintering birds has increased markedly, with a high proportion of birds staying, even in cold winters (Berndt & Busche 1991).

Gaps in knowledge

Historic moulting sites of Greylag Geese are mainly located in the Netherlands and Sweden. However, in recent years new (minor) sites have been established in the German Wadden Sea region. These sites require careful monitoring. It is not known whether or to what extent the increasing breeding population of the German Wadden Sea relies on immigration from inland sites. Effects on breeding birds of increasing numbers of mammalian and avian predators are insufficiently known. There is a need to assess the possible effects of competition with other species that have the same breeding habitat requirements, such as Cormorant, Mute Swan and Canada Goose.

Conservation actions

The protected status of moulting sites in the German Wadden Sea area should be maintained, in order to reduce disturbance. Although disturbance from recreational activities is a problem mainly at inland sites, it also needs to be dealt with in the Wadden Sea region. In many areas outside the national parks, farmers are allowed to scare geese on their fields, for example using automatic gas canons. Shooting and scaring both cause significant disturbance to the geese, but also to other non-target species (Lapwing, Black Tern). Shooting may increase the flush distances of the geese. Increased shyness could lead to more conflicts between recreation and nature conservation, and to a loss of foraging habitat for the geese. Agricultural damage caused by geese should not be dealt with by shooting, but by other means. The payment of compensation or adequately

tailored agri-environment schemes should be favoured and could be combined with measures to attract geese to special areas.

Pink-footed Goose *Anser brachyrhynchus*

Status: formerly passage/wintering

Global breeding range and populations

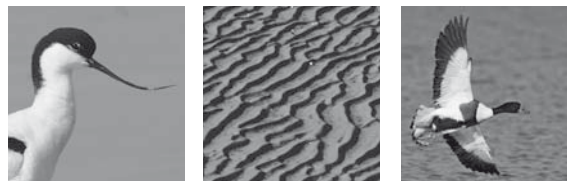
There are two separate breeding populations of Pink-footed Geese: the larger breeds on Iceland and in eastern Greenland, with birds wintering in Ireland and Great Britain. The second, much smaller population (42,000 individuals; Delany & Scott 2006), breeds in Svalbard, and the birds migrate to Denmark, the Netherlands, Belgium and – in severe winters – also as far as France (Bauer et al. 2005a). Formerly, a small proportion of this population (c.50-200 birds) stayed in the German Wadden Sea, but at present Pink-footed Geese are rare here. The European breeding population is estimated to be 50,000 – 69,000 pairs (BirdLife International 2004). Due to habitat destruction and persecution, both populations were in strong decline until the first half of the 20th century. Since then, the breeding population has increased, leading to higher numbers of birds wintering in Denmark. The global population of Pink-footed Goose is about 312,000 birds (Delany & Scott 2006).

Phenology in the German Wadden Sea, distribution and trends

Before the 1970s, a large proportion of the Svalbard population used the northern part of the German Wadden Sea, particularly marshes on the island of Föhr, as well as in the Rødenäs-Vorland near the Danish boarder. These two last important German stop-over sites have been lost due to agricultural intensification on Föhr, and a land claim in the Rødenäs-Vorland in 1981/1982 (for further details see Berndt & Busche 1991; Mooij 2000). Numbers of birds in the Niedersachsen Wadden Sea are lower compared with Schleswig-Holstein. During the 1980s, most birds were found in the Jadebusen (Goethe et al. 1985) and numbers of birds resting here have decreased steadily, as at all sites in the German Wadden Sea. At present, only small groups of Pink-Footed Geese can be found in the German Wadden Sea, as the main migration route towards the main wintering areas in the Netherlands crosses the German Bight (Hummel 1980).

Gaps in knowledge

It is not known why Pink-Footed Geese have not begun



to overwinter again in the German Wadden Sea, after the destruction of their last stop-over sites. The potential for management measures to enable re-establishment of this species in the German Wadden Sea should be assessed.

Conservation actions

Pink-footed Geese still suffer from disturbance in their staging areas (e.g. in Norway), as in many places goose scaring is very common (Bauer et al. 2005). The destruction of the last big German stop-over site due to land claim is an example of how bird species can be lost from the Wadden Sea. It is questionable whether the remaining habitats are sufficient to allow stop-over sites to be re-occupied. On the German Wadden Sea, Pink-footed Geese generally used mosaics of undisturbed (grazed) salt marshes and pastures (Berndt & Busche 1991), habitats which at present seem to be in short supply. Consideration should be given to re-establishing such areas. Although hunting of this species is not allowed in Germany and most other countries, there are still casualties, as this species is often confused with Greylag Geese.

Common Shelduck *Tadorna tadorna*

Status: breeding, passage/wintering

Global breeding range and populations

The Common Shelduck is a monotypic species breeding in two distinct areas: (1) from the north-east Atlantic coast including the North Sea and Baltic Sea; and (2) from south-east Europe in a narrow band as far east as China. There are three flyway populations, one in north-west Europe, the second in the Mediterranean/Black Sea area and the third in western Asia (Bauer et al. 2005a). The European breeding population is around 42,000 – 65,000 pairs and is more or less stable, apart from some declines during the 1990s, notably in Sweden and Great Britain (BirdLife International 2004). The world population is estimated to be 555,000 – 605,000 birds, with 300,000 individuals breeding in north-western Europe (Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trends

Compared with other European countries, the breeding population in Germany increased markedly until the beginning of the 21st century. In line with this wider increase, numbers of birds breeding in the German Wadden Sea also showed considerable increases between 1991 and 2001 (Koffijberg et al. 2006). However, in re-

cent years the breeding population has levelled off. In Schleswig-Holstein, 1,373 pairs were recorded in 2006 (Hälterlein, unpubl. data) and 2,910 pairs in Niedersachsen (Hälterlein; Südbeck, unpubl. data). In 2001 the total breeding population of the German Wadden Sea was estimated to be 6,480 breeding pairs, but since then there has been a moderate to strong decline to 4,691 pairs in 2006. Most Shelducks nest in rabbit holes, and on islands; in particular the East Friesian Islands in Niedersachsen, support most of the German Wadden Sea breeding population (Koffijberg et al. 2006). Many non-breeders use the Wadden Sea area during the summer months (Berndt & Busche 1995).

Phenology in the German Wadden Sea, distribution and trends

The German Wadden Sea is extremely important for moulting Shelducks. Between July and September, more than 200,000 flightless birds can be found near the Friedrichskoog peninsula in the outer Elbe estuary. They probably represent almost the entire north and north-west European population of the species. Numbers build up in July and slowly decrease again in September, when the freshly moulted adults disperse to other parts of the Wadden Sea and beyond. After the moult, around 50,000 birds can be found in many parts of Schleswig-Holstein and Niedersachsen. Lowest numbers occur in May. Winter numbers are correlated with temperature, and milder winters in recent years have led to a growing number of birds remaining in the Wadden Sea (for further details see Koffijberg et al. 2003; Blew et al. 2005a, b). During the 1990s, numbers of non-breeding birds in the German Wadden Sea increased steadily. However, more recently numbers have declined significantly, particularly in Schleswig-Holstein (Blew et al. 2007).

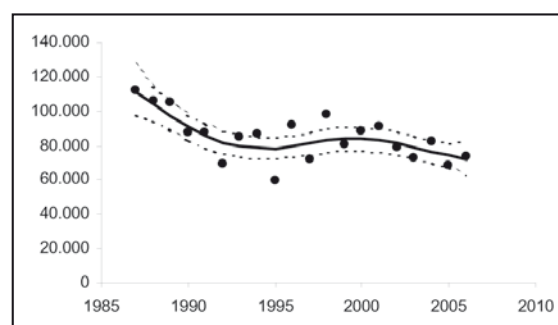


Fig. 8: Population trend of the Common Shelduck in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

There are indications that the breeding success of Common Shelducks has recently declined. The reasons for this are unclear. The importance of increased levels of predation (particularly on the islands - either by mammals or birds) should be investigated. Causes of population decline in the German Wadden Sea need to be assessed. In particular this should include potential changes in the quality of resting sites, such as abundance and quality of food, the role of disturbance etc. For several years, regular monitoring flights for Shelducks have been carried out to census the number of moulting birds. Some important shifts of moulting sites have been recorded in recent years. Reasons for these shifts remain unclear and should be investigated in connection with the question of site quality.

Conservation actions

Shelducks are completely flightless while moulting their wing feathers, which takes approximately 25-31 days (Bauer et al. 2005a). Oil exploration in the Wadden Sea National Park takes place within the core Shelduck moulting area. In particular, seismic surveys and oil platform maintenance traffic are important sources of disturbance for the birds, along with civil and military low flying aircraft, and local fishing and leisure boats. Traffic restrictions in the moulting areas during the moulting period are based on voluntary agreements and are probably insufficient.

Eurasian Wigeon *Anas Penelope*

Status: breeding, passage/wintering

Global breeding range and populations

The Eurasian Wigeon is a monotypic species that breeds from Western Europe throughout the Palearctic as far as eastern Russia (Bauer et al. 2005a). It is a rare, but in recent years regular breeding bird on the Wadden Sea coast and nearby inland sites. Its European breeding population is estimated to be 300,000 - 360,000 pairs. However, Europe is even more important as a wintering area, with more that 1.7 million birds staying over the winter (BirdLife International 2004). The world population is approximately 2.8 - 3.3 million birds, with 1.5 million in north-west Europe (Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trends

Only small numbers of Wigeon breed in the German Wadden Sea, which is near the southern edge of the

species' breeding range. In Niedersachsen, records of breeding are irregular, most commonly in the Elbe estuary and formerly also on Borkum (Heckenroth & Laske 1997). In contrast, this species has bred fairly regularly in Schleswig-Holstein since the 1980s, although only in very small numbers (e.g. Berndt et al., 2003). Most birds breed in polders, such as the Beltrhingharder Koog and the Hauke-Haien-Koog, which have been occupied most consistently (and by most birds) in recent years. In 2006, the breeding population in the Schleswig-Holstein Wadden Sea was 34 pairs, while in Niedersachsen no birds were recorded. The last records of breeding Wigeon in Niedersachsen were from Mellum, in 2003 (2 breeding pairs; Mellumrat, unpubl. data).

Phenology in the German Wadden Sea, distribution and trends

The first birds arrive from their breeding grounds in early September. Numbers build up rapidly and peak in October. The bulk of the birds commonly remain until February. By April, most birds have returned to their breeding grounds (for more details see Koffijberg et al. 2003; Blew et al. 2005a, b). Many birds forage on eel grass beds on the intertidal flats, but many others can be found at inland sites. By far the highest proportion of birds wintering in the German Wadden Sea can be found in Schleswig-Holstein (Blew et al. 2005b). The highest counts come from the Rickelsbüller-Koog, the Halligen, the Jadebusen and the Dollart. The Eider estuary and the Hauke-Haien-Koog in Schleswig-Holstein are important moulting sites (Berndt & Busche 1991). Since the 1980s, wintering numbers have increased steadily; this may be a result of milder winters. Over the last 10 years, numbers of the Eurasian Wigeon on passage have decreased significantly, particularly in Schleswig-Holstein (Blew et al. 2007).

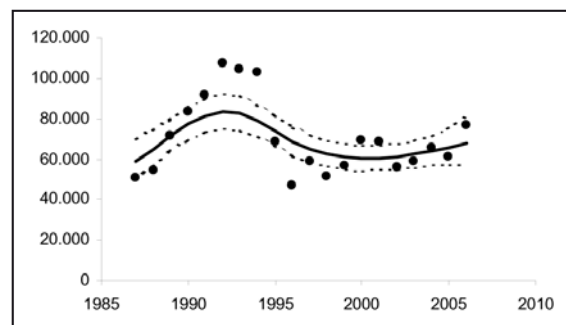
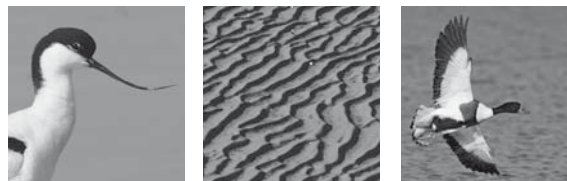


Fig. 9: Population trend of the Eurasian Wigeon in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.



Gaps in knowledge

Eurasian Wigeon are known to change foraging habitats according to the time of day, with a higher proportion of birds feeding at inland sites during the night. Reasons for this behaviour are still unclear. Effects of disturbance on the energy budgets should be investigated.

Conservation actions

Eurasian Wigeon may still be hunted in many parts of Schleswig-Holstein and Niedersachsen. In many areas outside the national parks, farmers are allowed to scare this species on their fields, using automatic gas canons. Shooting and scaring both cause much disturbance to the ducks, but also to other non-target species (Lapwing, Black Tern). Shooting may increase flush distances. The resulting increased shyness could lead to more conflicts between nature conservation and recreation interests, and to loss of feeding habitat for the ducks. Agricultural damage caused by this species should not be dealt with by shooting, but by other means. Payment of compensation or adequately tailored agri-environment schemes should be favoured, and this could be combined with measures to attract the birds to particular areas.

Common Teal *Anas crecca*

Status: breeding, passage/wintering

Global breeding range and populations

Two slightly different subspecies can be distinguished: (1) *Anas crecca crecca*, widely spread across the Palearctic; and (2) *A. c. nimia* breeding on the Aleutian Islands. The central European breeding range extends a long way south, with some birds breeding in low mountain ranges (Bauer et al. 2005a). The European breeding population holds more than 920,000 breeding pairs, with hot-spots in Russia and Finland. A slight decline was recorded across Europe during the 1990s (BirdLife International 2004). The world population is estimated at more than 5.9 million birds, with 500,000 individuals occurring in north-western Europe (Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trends

Common Teal breed throughout northern Germany, and are particularly common at lowland sites such as bogs and fens (for further details see Heckenroth & Laske 1997; Berndt et al. 2003). Smaller numbers can also be found in the Wadden Sea, where the species mainly breeds in polders (notably at the Beltringharder and Rickelsbüller Koog), at the Eider estuary (in Schleswig-Holstein), and on Borkum (in Niedersachsen). There

are several records from sandy islands such as Sylt, Amrum and several East Friesian Islands, where Common Teal use dystrophic dune ponds. On the coastal mainland of southern Schleswig-Holstein, Common Teal is absent as breeding species. In 2006, the breeding population in Schleswig-Holstein was approximately 34 pairs (Hälterlein, unpubl. data), while in Niedersachsen 29 pairs were recorded (Staatliche Vogelschutzwarte im NLWKN; Mellumrat, unpubl. data). During the 19th century, the breeding population experienced a strong decline, due to drainage of breeding habitats, but numbers have increased slightly in recent decades because of improvements in the mainland breeding habitats, such as measures to encourage water-logging (Goethe et al. 1985; Berndt & Busche 1991). This might also have caused positive effects on the breeding population.

Phenology in the German Wadden Sea, distribution and trends

Compared to freshwater sites, the Wadden Sea is used only moderately by non-breeding Common Teals. Between 5 and 10% of the north-west European breeding population use the German Wadden Sea outside the breeding season (Blew et al. 2005b). Numbers in the Wadden Sea start to increase during August and peak during September and October. Numbers are generally far higher in Schleswig-Holstein than Niedersachsen (Blew et al. 2005b). During severe winters, most birds migrate further south and west, to Great Britain, the Netherlands and northern France (Berndt & Busche 1991). Important moulting areas are located close to ponds in the reclaimed polders (such as the Beltringharder Koog and the Dithmarscher Speicherkoog) and estuaries (e.g. the Elbe and Eider) (Berndt & Busche 1991). Numbers of non-breeding Common Teal have declined somewhat, particularly in Schleswig-Holstein (Blew et al. 2007; Fig. 10). Population trends in the German Wadden Sea may differ between months (Blew et al. 2005a).

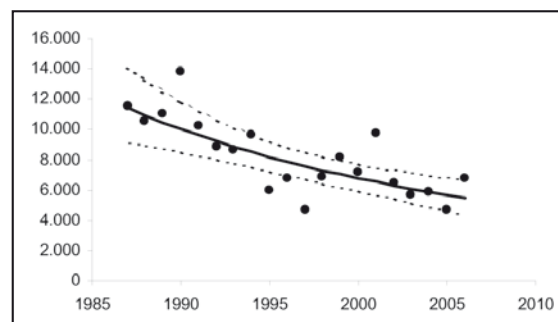


Fig. 10: Population trend of the Common Teal in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

Exchange rates between coastal and mainland sites are not yet described. Potential mechanisms of competition with other species at resting sites, potentially leading to avoidance of suitable habitats, remain unclear.

Conservation actions

The species relies on dystrophic wetland sites for breeding and resting. These areas should be carefully managed and potentially re-created to suit Common Teals as breeding and resting habitat. Water extraction on dune islands has lowered water tables, thus causing a deterioration of dune slacks: this practice should be regulated. Hunting should be restricted, as it is currently still allowed during the winter months in many areas in both Schleswig-Holstein and Niedersachsen. At many important resting areas, this species still suffers from disturbance caused by leisure activities. The impact of accumulated toxins in shallow wetland foraging habitats should be regarded as potential problem.

Mallard *Anas platyrhynchos*

Status: breeding, passage/wintering

Global breeding range and populations

There are two subspecies of Mallard, *Anas platyrhynchos platyrhynchos* with a Holarctic distribution, and *A. p. comboschas* which breeds on Greenland. Clear classifications of the relationships in the super-species complex are difficult, as genetic studies are lacking (Bauer et al. 2005a). The summer population includes a high proportion of non-breeding birds. The breeding population in Europe is estimated to be 3.3 – 5.1 million pairs and has been stable in recent years (BirdLife International 2004). The world population is approximately 20.6 million birds, with 4.5 million occurring in north-west Europe (Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trends

The Mallard is a very common breeding bird throughout central Europe, and occurs in the German Wadden Sea area, as well as inland. It is an opportunistic species and is able to respond quickly to human activities, and may establish new breeding sites in the Wadden Sea region in places such as inland gravel pits, open sites resulting from coastal defence activities, or reclaimed polders. Behind the seawall, the extensive ditches in the marsh are also commonly used by breeding Mallard (for further details see e.g. Heckenroth & Laske 1997; Berndt

et al. 2003). The number of breeding pairs in the Wadden Sea is high. In 2006, around 1,180 breeding pairs were recorded in Schleswig-Holstein (Hälterlein, unpubl. data), and there were more than 715 pairs in Niedersachsen, with the largest numbers recorded on Borkum, Langeoog and Spiekeroog (Staatliche Vogelschutzwarte im NLWKN; Mellumrat, unpubl. data). Mallard mainly breed in polders, in the marshland ditches of the Halligen, or in heavily vegetated foreland salt marsh. Breeding numbers in the Wadden Sea have been more or less stable in recent years.

Phenology in the German Wadden Sea, distribution and trends

Non-breeding Mallard in the Wadden Sea are frequently found on coastal defence works at high tide, and close to the banks of tidal creeks during low water (Berndt & Busche 1991). While numbers in the German Wadden Sea are generally low during summer, they increase in June, as Mallard use the Wadden Sea for moulting (Meltofte et al. 1994). Peak numbers in the German Wadden Sea occur during the winter months, with similar numbers of birds in the Schleswig-Holstein and Niedersachsen parts of the Wadden Sea. Winter numbers are highly dependent on winter temperatures. However, numbers on the tidal flats tend to remain quite high even during ice winters, whereas numbers using the polders decrease substantially (Berndt & Busche 1991). In March, most of the non-breeding birds leave the Wadden Sea for their breeding sites in the North (Blew et al. 2005a, b).

Spring and particularly autumn numbers declined significantly during the 1990s (Blew et al. 2005a, b). The overall trend in the German Wadden Sea is also downwards (Blew et al. 2007; Fig. 11).

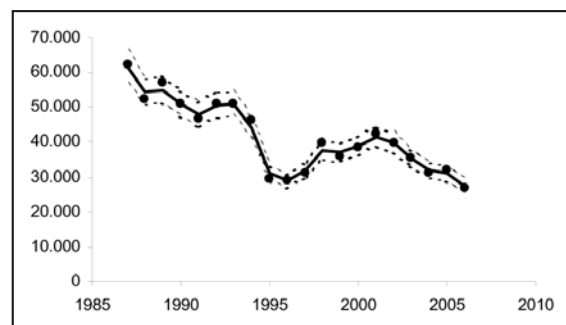
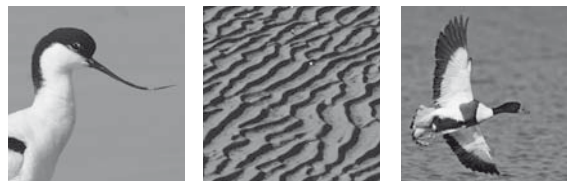


Fig. 11: Population trend of the Mallard in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.



Gaps in knowledge

Reasons for the drop in numbers during spring and autumn migration remain unclear. The significance of hybridisation with domesticated ducks is uncertain. The effects of anthropogenic activities on Mallards should be investigated.

Conservation actions

Outside protected areas, hunting still causes direct (mortality) and indirect (disturbance) negative effects. Hybridisation with domesticated ducks might potentially be an increasing problem, though negative influences on the breeding population are so far not proved (Bauer et al. 2005). Accumulation of pollutants in shallow water foraging habitats should be regarded as potential problem. Birds are regularly found dead at coastal foraging and resting sites in the Wadden Sea due to oiling.

Northern Pintail *Anas acuta*

Status: breeding, passage/wintering

Global breeding range and populations

This monotypic species breeds throughout the Holarctic in North America, Europe and Asia, from tundra to grassland habitats. To the south-east of Poland, breeding Northern Pintails are scarce (Bauer et al. 2005a). The European breeding population is more than 320,000 pairs, with a major concentration in Russia; however major declines occurred between 1970 and 1990. Since then, breeding numbers have increased slightly in most countries, but the downward trend in Russia has not been reversed (BirdLife International 2004). The world population of Northern Pintail is estimated to be more than 3.5 million birds, 60,000 of which are found in north-west Europe (Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trends

The Northern Pintail is a rare breeding bird in the Wadden Sea, with a very small population found mainly in polders. However, in recent years there have been regular breeding records in the German Wadden Sea area, which must be due to increasing numbers of suitable sites (such as reclaimed polders with extensive shallow ponds, in different stages of natural succession; Berndt & Busche 1991; Berndt et al. 2003). During the 1990s, the estimated population in the German Wadden Sea was 10-12 pairs (Hälterlein et al. 2000). In Schleswig-Holstein, most of the important breeding sites in the Wadden Sea are located in the polders in Nordfriesland,

such as the Beltringharder and the Rickelsbüller Koogs. In 2006, 24 pairs bred in Schleswig-Holstein. In Niedersachsen, a few pairs bred regularly on the island of Borkum (Heckenroth & Laske 1997), where two breeding pairs were recorded in 2006 (Staatliche Vogelschutz-warte im NLWKN, unpubl. data). Overall, the breeding population in the German Wadden Sea has been more or less stable during recent years.

Phenology in the German Wadden Sea, distribution and trend

Numbers of non-breeding Northern Pintails in the Wadden Sea are highest in September–October, and in March–April, and account for 10 – 15% of the north-western European breeding population (Blew et al. 2005a; b). In winter, numbers remain quite high, though clearly depending on winter temperatures (Blew et al. 2005a). Year round – but particularly in autumn – numbers are highest in the Schleswig-Holstein Wadden Sea (Blew et al. 2005b). Important hot-spots for non-breeding Northern Pintails include the conservation polders of the Wadden Sea coast with their shallow ponds, as well as sheltered bays like the Jadebusen (Meltofte et al. 1994). Non-breeding numbers vary greatly according to environmental conditions such as precipitation, food availability, temperature etc. (Blew et al. 2005a). Numbers of Northern Pintail in the Wadden Sea have increased slightly in the International Wadden Sea in recent decades (Fig. 12); however, this increase might be a result of redistribution of birds from other regions, such as Great Britain (Blew et al. 2007).

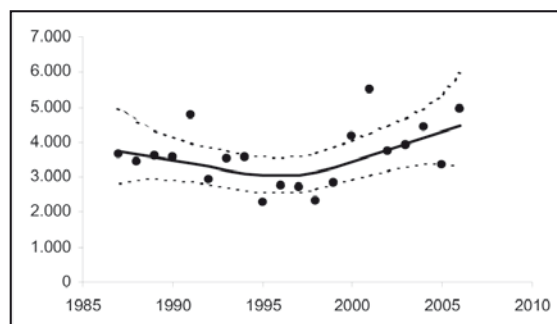


Fig. 12: Population trend of the Northern Pintail in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

Currently, regional variations in roosting and foraging habitat are not well known, nor the extent to which they use coastal tidal flats for foraging and resting. Non-breeding bird numbers in the German Wadden Sea should

be monitored carefully, to enable comparison with the downward trend of the breeding population in north-east Europe (BirdLife International 2004). Redistribution and movements of non-breeding Northern Pintails in western Europe should be investigated, in order to elucidate regional patterns of population change.

Conservation actions

Northern Pintails are listed on all country Red Lists in Central Europe. This species requires undisturbed resting sites, such as sheltered coastal bays, or ponds in reclaimed polders. These habitats should be protected and carefully managed. Breeding numbers in the German Wadden Sea would probably benefit from improvements of breeding habitat on the adjacent mainland, to enable a spread out from these sites. Conservation and enhancement of fens and wetlands on the mainland would be required.

Northern Shoveler *Anas clypeata*

Status: breeding, passage/wintering

Global breeding range and populations

The Northern Shoveler is a monotypic species that breeds throughout the Holarctic as far north as the 12° C July isotherm; in the south, its range extends to the Mediterranean, the steppe and desert zones of Asia, and to central North America (Bauer et al. 2005a). The species is widespread in northern and north-east Europe, but has only a patchy breeding distribution further south. The European breeding population is estimated to be 170,000 – 210,000 pairs; the trend in Europe is downwards, due to large declines in breeding numbers in particular in the Netherlands and Poland (BirdLife International 2004). The global population is approximately 5.5 to 6 million birds, 40,000 of which occur in central and north-west Europe (Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trends

Most Northern Shovelers breed close to periodically inundated river-marshes, or in shallow eutrophic ponds, or in wet pastures. Thus, their mainland breeding distribution in Schleswig-Holstein and Niedersachsen shows clear aggregations in or close to the Elbe, Ems, Weser and Eider estuaries (Berndt & Busche 1991; Heckenroth & Laske 1997). Northern Shovelers have bred regularly in the Wadden Sea area since the 1960s (Goethe et al. 1985). However, the breeding population in the German Wadden Sea is still very small compared with numbers

at sites on the adjacent mainland. Most birds breed in polders, such as the Dithmarscher Speicherkoog, Hauke-Haien-Koog, Beltringharder Koog etc., with only a small proportion in the marshes of the islands and Halligen (Berndt & Busche 1991; Hälterlein 1998; Berndt et al. 2003). In 2006, the breeding population in the Wadden Sea of Schleswig-Holstein was estimated to be around 400 pairs (Hälterlein unpubl.), which represents an increase compared with earlier years (Hälterlein, 1998). No data on breeding numbers are available for Niedersachsen. During the 1980s, most breeding attempts in the Niedersachsen Wadden Sea have been on the islands Borkum, Juist and Norderney (Goethe et al. 1985).

Phenology in the German Wadden Sea, distribution and trends

The largest numbers of Northern Shovelers occur during September to November, with a clear peak during October; many more non-breeding birds are found in Schleswig-Holstein compared to Niedersachsen (Blew et al. 2005a, b). During October approximately 10% of the north-western European breeding population can be found in the German Wadden Sea (Blew et al. 2005b). Winter numbers depend on temperature. From late March to late April, a smaller peak than in autumn occurs on spring migration. The most important non-breeding sites in the German Wadden Sea are the estuaries, and the conservation polders with their shallow ponds. However, Shovelers can be found on both sides of the seawall in areas with shallow water, muddy substrate and wet pastures (Meltofte et al. 1994). In recent years, numbers of Northern Shovelers in the Wadden Sea have increased, particularly during the spring migration (Blew et al., 2005a; 2007).

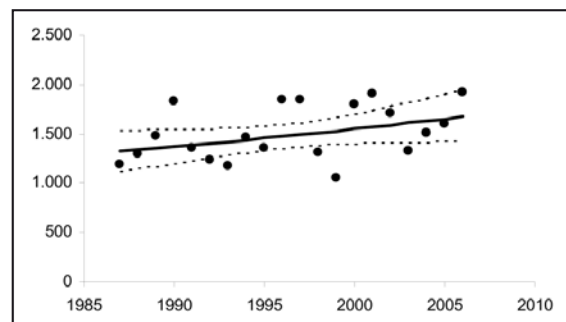
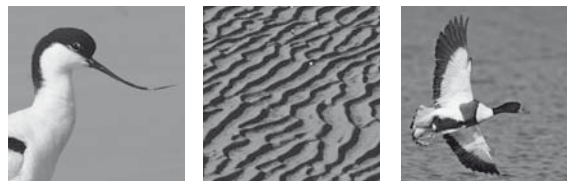


Fig. 13: Population trend of the Northern Shoveler in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.



Gaps in knowledge

There is no detailed knowledge of the population dynamics of this species, nor of the proportion of non-breeding birds present during summer. Regional movements of birds between Wadden Sea sites and the mainland are not yet known.

Conservation actions

Dramatic changes in landscape and agricultural practice on the mainland marshes next to the Wadden Sea have led to a loss of low-vegetated, wet ditches and fewer extensively managed wet pastures (Berndt & Busche 1991). Although eutrophication of wetland sites could be considered as generally beneficial to this species, the loss of suitable habitat further inland might also influence numbers and phenology of Northern Shovelers in the Wadden Sea area. Agri-environment schemes targeted at wet pastures and flood plains would probably improve habitat for Northern Shovelers. Increased water levels at wetland sites have already led to increases in breeding numbers, for example in the Dümmer area of Niedersachsen (Goethe et al. 1985). Both hunting and pollution of areas of shallow water still cause significant problems for Northern Shovelers.

Common Eider *Somateria mollissima*

Status: breeding, passage/wintering

Global breeding range and populations

The Common Eider is divided into six subspecies, all of them breeding in coastal regions of the Arctic and boreal zone. Distribution is roughly circumpolar, from north-west Europe to North America. Common Eider breed as far north as Svalbard, while the most southerly breeding records come from northern France and from an isolated population in the Black Sea (Bauer et al. 2005a). Originally, Common Eider were mainly restricted to coasts, but during recent years an increasing number of records have come from inland sites (Bauer et al. 2005a). Three subspecies breed in Europe: (1) *Somateria mollissima mollissima* from France and Great Britain to the Baltic Sea; (2) *S. m. islandica* in north Norway, Svalbard, Iceland and Greenland; and (3) *S. m. faeroensis* which is restricted to the Faroe Islands (Bauer et al., 2005a). There are 840,000 – 1.2 million breeding pairs in Europe, with a major concentration in Scandinavia (BirdLife International 2004). The European breeding population declined substantially during the 1990s, but since 2000 numbers have stabilised or even increased in a number of countries (BirdLife International 2004).

The world population is estimated to be more than 3 million birds, around 760,000 of which are found in the Baltic or in the Wadden Sea (Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trends

Common Eider are first known to have bred in the German Wadden Sea in the 18th century, on the island of Sylt (Berndt & Busche 1993). While Eiders once bred exclusively in dunes, in recent years breeding in reeds, pastures or even on agricultural land has become increasingly common (Berndt & Busche 1993; Hälterlein, 1998). Numbers of Common Eider breeding in the German part of the Wadden Sea are far lower than in the Netherlands. The Wadden Sea is the only German breeding area for Common Eider, with the exception of a few records from the Baltic and Helgoland (Heckenroth & Laske 1997; Berndt et al. 2003). Breeding numbers in the Wadden Sea in the 1970s were estimated at more 2,200 pairs (Berndt & Busche 1993), but nowadays the population is very small. In Schleswig-Holstein 130 – 300 pairs were found in recent years, while there were around 980 pairs in Niedersachsen in 2006 (Hälterlein unpubl.; Südbeck unpubl.). Nearly all breeding sites are on islands: Borkum, Mellum and Amrum are the most important. The number of breeding birds in the Niedersachsen Wadden Sea increased steadily between 1991 and 2001, concentrated on the island of Borkum. Conversely, numbers on Amrum declined from 808 pairs in 1991, to 382 pairs in 2001 (Koffijberg et al. 2006). This coincided with mass mortality events of Eiders during the winter of 1999/2000, when 21,000 birds starved to death in the Netherlands and a further 10,000 birds in Germany (Camphuysen 2001; Camphuysen et al. 2002). Breeding numbers of Common Eider on the island of Amrum have declined, whilst increasing numbers have been recorded the island of Föhr and on the Halligen of Norderoog and Süderoog. Due to difficulties in censusing the species, the actual population size on the island of Amrum remains uncertain. In spite of declines in the Schleswig-Holstein part of the Wadden Sea, the overall trend for the German Wadden Sea as a whole seems to be stable, due to increasing numbers in Niedersachsen.

Phenology in the German Wadden Sea, distribution and trends

The German Wadden Sea holds large numbers of non-breeding Eider during the summer, predominantly immatures. During the migration period and particularly in winter, considerable numbers of Eiders, originating mainly from the Baltic Sea, are found in the Wadden Sea (Franzmann 1983; Meltofte et al. 1994; Skov et al.

1995; Blew et al. 2005a, b). During the non-breeding period, Common Eiders mainly stay offshore over shallow banks, or on tidal flats and at the edge of tidal creeks in the Wadden Sea itself. The German Wadden Sea is an important moulting site during autumn (mainly July – September), when up to 250,000 birds can be present (Blew et al. 2005b). Depending on temperature, between 100,000 and 150,000 birds remain in the German Wadden Sea over the winter (Blew et al. 2005). Regional shifts in distribution over the course of a season, as well as between years, could be a result of prey abundance and availability (Nehls 1991; Scheiffarth & Frank 2005). Numbers of Common Eiders in the Wadden Sea – particularly in Schleswig-Holstein during winter – have declined substantially in recent years (Blew et al. 2005a; 2007; Fig. 14).

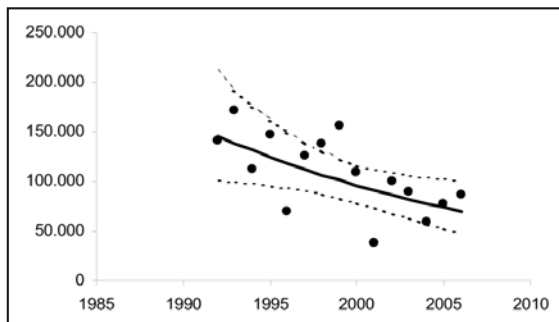


Fig. 14: Population trend of the Common Eider in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

The reasons for the population decline on the island of Amrum are not yet understood. Regional redistribution of breeders in the Wadden Sea should be investigated in more detail, and the reasons for these regional movements elucidated. Energetic constraints on Common Eider due to disturbance (particularly from ships) at different times of the year should be investigated. The effects of changes in the main food supply, particularly Blue Mussels (for example due to climate change or invasive species), should be investigated, as they could lead to mass mortality of Common Eider during winter. More information on the foraging ecology of Common Eider is needed in order to evaluate the effects of mussel fisheries. While a monitoring programme has been initiated for mussels, there is virtually no current information on cockle stocks (the second most important food source for Common Eider). This information is urgently needed to understand the relationships bet-

ween population trends and food availability for Eiders in the Wadden Sea.

Conservation actions

Common Eiders in the Wadden Sea suffer from disturbance caused by shrimp fisheries and leisure boats (in particular due to noise), and by civil and military aircraft. Although flush distances in front of approaching vessels are less than for other sea duck species such as Common Scoter (Schwemmer et al. *subm.*), Common Eider suffer energetic constraints due to disturbance. Human activities of these kinds should be prohibited in high-density areas of Common Eider, particularly during the sensitive moulting period (when many individuals are flightless). Chronic oil pollution in the Wadden Sea must be regarded as major threat for Common Eider. The species is considered to be likely to be adversely affected by the construction of offshore wind farms (disturbance and habitat loss; Garthe & Hüppop 2004), which may also effect distribution and population dynamics in the Wadden Sea. Common Eider consume by far the highest amount of shellfish of all Wadden Sea bird species, and this causes severe conflicts with mussel fisheries (Scheiffarth & Frank 2005). A species management plan should be developed.

Common Scoter *Melanitta nigra*

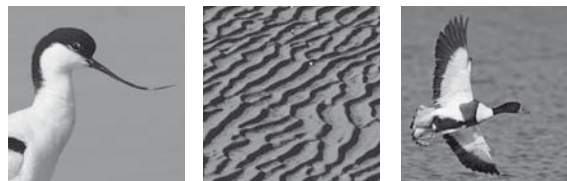
Status: passage/wintering

Global breeding range and populations

The Common Scoter is a monotypic species that breeds from Iceland, through northern Great Britain and northern Eurasia to eastern Siberia. The European breeding population has been stable in recent years and consists of about 100,000 – 130,000 pairs, the vast majority of which breed in Russia (BirdLife International 2004). The world population is estimated to be around 1.6 million birds (Delany & Scott 2006). Common Scoters do not breed in the Wadden Sea area, but use the adjacent offshore areas as a major wintering site.

Phenology in the German Wadden Sea, distribution and trends

Most non-breeding Common Scoters occur just outside the Wadden Sea, in the adjacent offshore zone. Numbers are highest in winter, when large aggregations can be found in the North-Friesian offshore zone, on the edge of the Wadden Sea. This area is of international importance during the winter months (Skov et al. 1995). Aggregations north of the East Friesian Islands



are much smaller (e.g. Mendel et al. 2008). Garthe et al. (2007) estimated numbers in the 12 nm-zones of Schleswig-Holstein and Niedersachsen during winter to be around 135,000 birds. Numbers at other times of the year are much lower, but there are a number of aggregations in summer, particularly near the Eiderstedt peninsula, and north of the East Friesian Islands, where flocks are smaller. These sites are mainly used for moulting by males and immatures (e.g. Hennig 2001; Garthe unpubl. data). The summer population of the coastal areas of the German North Sea is estimated at 66,000 birds (almost all in the waters of Schleswig-Holstein; Garthe et al. 2007). Numbers are lowest in autumn (18,500 birds spread equally between Schleswig-Holstein and Niedersachsen; Garthe et al. 2007). There seems to be a high degree of turnover in the choice of resting sites, with many individuals changing sites (at least regionally) during the course of the non-breeding season (e.g. Offringa 1993; Platteeuw 1990).

Gaps in knowledge

Not enough is known about patterns of regional movements, or rates of exchange between important resting and foraging sites, e.g. individuals wintering in Denmark, Germany and the Netherlands (e.g. Nehls 1998). Influence of winter temperatures on the distribution patterns of Common Scoter are not understood. In this context, the effect of climate change on prey abundance and energetics needs to be evaluated. Little is known about the origin of birds involved in different moulting, resting and winter aggregations in German waters. There have been no studies of the foraging ecology of this species in Germany. There is little current understanding of the influence of various increasing anthropogenic effects in the coastal zone and offshore area. Energetic constraints on Common Scoters at different times of the year due to disturbance (particularly by ships) should be the subject of detailed investigation.

Conservation actions

As non-breeding Common Scoters occur exclusively at sea, they are very vulnerable to oil spills and chronic oil pollution. A survey of beached birds conducted during the winters 2000/01 and 2001/02 found a considerable proportion of oiled birds (Fleet et al. 2003). Common Scoters are very prone to disturbance: flush distances in front of approaching ships are very high and can be more than 1 km (Kaiser et al. 2006; Schwemmer et al. subm.). Important sources of disturbance include shrimp fisheries and leisure boats (in particular due to noise), as well as civil and military aircraft. Human activities of these kinds should be prohibited as a matter

of urgency where they take place in high-density areas of Common Scoters, particularly during the sensitive moulting period (when many birds are flightless). Scoters are thought likely to be adversely affected by the construction of offshore wind farms (disturbance and habitat loss; Garthe & Hüppop 2004), and also by mussel fisheries (reduced food availability). A species management plan should be developed.

Hen Harrier *Circus cyaneus*

Status: breeding, passage/wintering

Global breeding range and populations

The Hen Harrier is a widespread, monotypic species with a large breeding range. Its core area extends from north-east Europe to the Pacific. The highest densities are found in Russia and Finland, but also in some parts of western Europe, particularly in France, where this species occurs throughout the year (Bauer et al. 2005a). The breeding distribution in Germany is dispersed, with the highest densities on the East Friesian Islands. The breeding population in Europe is small (less than 59,000 pairs) and declined considerably between 1970 and 1990, with only a slight recovery since then (Bird-Life International 2004).

Breeding population size in the German Wadden Sea, distribution and trend

The German breeding population of Hen Harriers is almost entirely confined to the Wadden Sea islands of Niedersachsen (Boschert 2005), where they have bred since 1952 (Dierschke 2008). Most Hen Harriers in the Wadden Sea breed on Borkum, Spiekeroog and Norderney. In all, 43 breeding pairs were recorded in Niedersachsen in 2006. By contrast, in Schleswig-Holstein, in recent years the only regular breeding has been by single pairs on Sylt or Föhr (Südbeck unpubl.; Hälterlein unpubl.). Occasionally, a few breeding attempts have been made in the Dithmarscher Speicherkoog (Berndt et al. 2003). Numbers increased significantly on the Wadden Sea coast during the 1990s (Hälterlein et al. 2000). In Niedersachsen, the breeding population almost doubled between 1991 and 1997, when a peak of 55 pairs was reached. Since then, significant declines have taken place and only 34 pairs were present in 2007 (Dierschke 2008). The neighbouring Dutch population has also declined significantly. Here, numbers declined from 130 to 32 pairs between 1994 and 2008, an annual rate of change of between -10% and -19%; the reasons are mostly unknown (Klaassen et al. 2009).

Phenology in the German Wadden Sea, distribution and trends

Hen Harriers are not recorded systematically during high tide roost counts on the Wadden Sea coast. Thus, no trend is available for non-breeding numbers over the years. Generally, Hen Harriers from north and north-east Europe are known to migrate comparatively short distances south after the breeding season. In central Europe, many are resident year round, subject to winter temperatures (Bauer et al. 2005a).

Gaps in knowledge

Currently it is not known if mammalian predators are likely to affect the breeding success of Hen Harriers on the islands. The influence of vegetation structure on foraging success should be investigated, in order to create basic information to inform site management. Switches of breeding site (between the East Friesian Islands) may occur and should be investigated by a ringing programme. Foraging sites on the mainland should be identified, in order to allow better management.

Conservation actions

Better protection of the breeding population is needed. Differences in distribution, breeding numbers and density between Niedersachsen and Schleswig-Holstein are not yet understood. Disturbance of breeding birds is thought to be a major factor influencing the numbers and distribution. The Hen Harrier is a ground nester that is likely to suffer from mammalian predators. Predator control on the islands is recommended, in order to enhance breeding success. Hen Harriers need foraging sites at an early stage of natural vegetation succession. Such sites may be lacking, due to a loss of dune dynamics and vegetation becoming rank. Water extraction should be restricted on dune islands, where it has caused lowered water tables, and thus a deterioration of dune slacks. At a global scale, Hen Harriers have suffered from pollution from organochlorine pesticides. The current impact of these substances on birds using the Wadden Sea area is unclear. Harriers can collide with fences: barbed wire used in fences should be replaced by plain-gauge wire, and unnecessary fences should be removed to reduce the direct loss of birds.

Peregrine Falcon *Falco peregrinus*

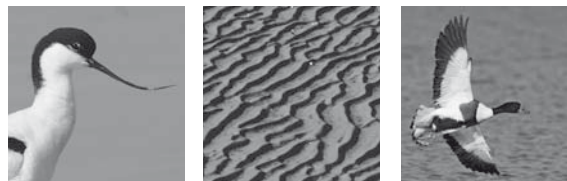
Status: breeding, passage/wintering

Global breeding range and populations

The Peregrine Falcon occurs in 17 subspecies worldwide. There are three subspecies in Europe: (1) *Falco peregrinus peregrinus* breeds in central Europe; (2) *F. p. calidus* from northern Europe to Siberia; and (3) *F. p. brookei* from the Mediterranean to Iran (Bauer et al. 2005a). The Peregrine Falcon is a widespread but patchily distributed breeder across much of Europe, Russia, North America and Greenland. During the 1980s the world breeding population was carefully estimated at c.12,000 – 18,000 pairs (del Hoyo et al. 1994). However, in 2000 the European breeding population alone held c.12,000 – 25,000 pairs (BirdLife International 2004). Apart from the Turkish breeding population, the Peregrine has shown strong increases in breeding numbers particularly in Europe during the most recent decades (BirdLife International 2004).

Breeding population size in the German Wadden Sea, distribution and trend

Breeding numbers in northern Germany decreased strongly during the first half of the 20th century until this species became extinct, at least in Schleswig-Holstein (Berndt & Busche 2003). During the 1980s, resettlement of northern Germany began, following releases of captive birds (for more details see Berndt & Busche 2003). Since then, the population trend has been strongly upward. In line with the positive European trend, breeding numbers around the German Wadden Sea increased most strongly in the 1990s, and this trend has continued during recent years (Heckenroth & Laske 1997). Birds in or at the edge of the German Wadden Sea nearly all nest on man-made structures such as buoys, or industrial buildings (Berndt & Busche 2003). In Schleswig-Holstein, Peregrines mainly nest on the outer sand banks (for more details see Hälterlein 1998), where ground nesting has become common. In 2009, the breeding of a mixed pair (male from the Wadden Sea, female from cliff-breeding parents) has been recorded on the island of Trischen. Breeding numbers in Schleswig-Holstein in recent years are estimated to be fewer than 5 pairs. This species has bred most frequently on the island of Trischen. Similar numbers as in Schleswig-Holstein were recorded during the 1990s around the Niedersachsen Wadden Sea (Heckenroth & Laske 1997). Here, in 2006 single pairs were recorded both on Lütje Hörn and Mellum (Staatliche Vogelschutzwarte im NLWKN; Mellumrat, unpubl. data).



Phenology in the German Wadden Sea, distribution and trends

Peregrine Falcons are highly migratory, and the bulk of the north European breeding population moves to central or southern Africa during the non-breeding period (del Hoyo et al. 1994). However, increasing numbers of birds spend the non-breeding period in central Europe, including the Wadden Sea (for more details see Berndt & Busche 2003).

Gaps in knowledge

As a bird of prey that hunts mainly on birds, the Peregrine has a huge impact on shorebirds and ducks. Currently it is not known to what extent Peregrines influence the distribution and habitat quality of their prey. Information on numbers and distribution of Peregrines in the German Wadden Sea during the non-breeding period are currently lacking.

Conservation actions

During the 1960s and 1970s Peregrines suffered worldwide from contamination by pesticides. Although in many countries the use of these substances have been banned, their current impact on birds using the Wadden Sea area is still unclear. There is no need for nesting platforms to be added to man-made structures in the Wadden Sea, as the species has recovered well, and ground nesting occurs regularly.

Eurasian Oystercatcher *Haematopus ostralegus*

Status: breeding, passage/wintering

Global breeding range and populations

There are three subspecies of Eurasian Oystercatcher: (1) *Haematopus ostralegus ostralegus*, breeding in the western Palearctic; (2) *H. o. longipes* in east Europe and west Asia; and (3) *H. o. osculans* in the eastern Palearctic (Bauer et al. 2005a). Oystercatchers use coastal regions intensively, but can also be found in inland areas both as a breeding bird and (more irregularly) during the non-breeding season (Bauer et al. 2005a). It is patchily distributed throughout Europe with a breeding population of c.300,000 – 400,000 pairs (BirdLife International 2004). Although BirdLife International (2004) has evaluated Oystercatchers as secure, there have been dramatic declines in breeding numbers particularly in the Netherlands since 1990, and in recent years these decreases have also started in Germany (see below). The total population of Eurasian Oystercatcher occurring in

north, central and west Europe is estimated to be c.1.1 million birds (Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trends

Oystercatchers breed across the entire Wadden Sea area, where 12% of the north-west European population can be found (Koffijberg et al. 2006). About 69% of the Wadden Sea population is found on the islands and Halligen, with the highest breeding densities on salt marshes (Koffijberg et al. 2006). The largest populations in the German Wadden Sea are located on the Halligen of Schleswig-Holstein, and on Norderney and Langeoog in Niedersachsen (Zang et al. 1995; Berndt & Busche 2003). Oystercatcher populations in Germany have been increasing for many decades. The population trend at the German Wadden Sea changed abruptly in 1997 (Hötker et al. 2007). In that year, a consistent and severe population decline started that has not yet come to a halt. In the Netherlands, the decline started earlier, and was attributed to a mass mortality in the winter 1995/96 due to food shortage as a result of overfishing of mussels and cockles. In Schleswig-Holstein 16,347 breeding pairs of Oystercatcher were counted in 2001 (Koffijberg et al. 2006), but only 10,331 pairs in 2006. In Niedersachsen numbers were estimated to be 10,957 pairs in 2001 (Koffijberg et al. 2006), but only 9,865 in 2006. Extensive studies in the Netherlands and also in Germany (Becker 1987) showed that Oystercatchers breeding in territories with direct access to intertidal flats had much higher breeding success than the those breeding further away. At the same time as breeding numbers have declined on the Wadden Sea islands and salt marshes in recent years, overall breeding success of Oystercatcher has also clearly decreased (Hötker et al. 2007).

Phenology in the German Wadden Sea, distribution and trends

Numbers of Oystercatchers in the German Wadden Sea is far higher during the non-breeding season than in the breeding season, with similar numbers in Schleswig-Holstein and in Niedersachsen (Blew et al. 2005b). The main peak generally occurs around September to October (Koffijberg et al. 2003). However, high numbers of Oystercatchers remain in the Wadden Sea even during cold winters, accounting for as much as about half of the flyway population (Blew et al. 2005a). During severe winters with ice cover, mass mortality events of Oystercatchers have been recorded in the Wadden Sea, e.g. in the winters 1962/63, 1986/87 and 1995/96 (for more details see e.g. Behm-Berkelmann & Heckenroth

1991). Numbers of non-breeding Oystercatchers in the German Wadden Sea have shown substantial declines since the 1990s (Blew et al. 2005a; 2007; Fig. 15).

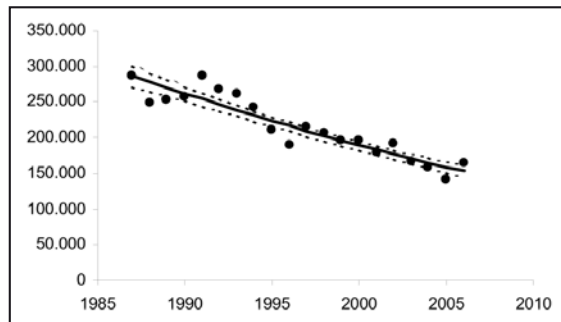


Fig. 15: Population trend of the Eurasian Oystercatcher in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

Reasons for poor breeding success and population declines need to be assessed. The role of coastal defence measures on breeding success and in particular on chick mortality should be investigated. Although there is already basic information on the foraging ecology of Oystercatchers, more detailed studies are needed to evaluate the effects of mussel fisheries. While a monitoring programme has been already initiated for Blue Mussels, at present there is virtually no information on cockle stocks. Such information is urgently needed to understand the relationships between food availability and population trends of Oystercatchers in the Wadden Sea. Currently, it is not known to what extent Oystercatchers may suffer from a reduction of the availability and quality of shellfish in the Wadden Sea. Effects of climate change on shellfish need to be studied. The role of egg and chick predation by mammals and birds is not currently sufficiently understood.

Conservation actions

Ens et al. (1992) and Becker (1987) showed that the reproductive success of Oystercatchers depends on quick access to foraging sites. Ideally, adults would be able to lead their young directly into the foraging habitat on foot, which would save much time in presenting the collected prey items to the chicks. However, in many coastal regions of the German Wadden Sea, access for chicks to foraging sites is no longer possible, due to impassable coastal defences. The design of many coastal constructions such as giant loose boulders, or fixed salt

marsh edges should be altered to allow chicks access to their foraging habitat. Oystercatchers consume a considerable quantity of shellfish, and this causes conflicts with mussel fisheries in the Wadden Sea (Scheiffarth & Frank 2005).

Avocet *Recurvirostra avosetta*

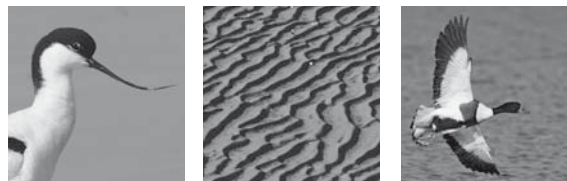
Status: breeding, passage/wintering

Global breeding range and populations

The breeding range of this monotypic species is split into different regions. There are several hot-spots in the western Palearctic as well as in tropical, east and southern Africa and in a number of semi-desert zones from south-east to central Asia (Bauer et al. 2005a). The European breeding population is 38,000 – 57,000 breeding pairs (BirdLife International 2004). The world population is estimated to be more than 209,000 birds with c.73,000 occurring in west Europe, which accounts for the largest breeding population in the world (Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trends

Avocets breed in coastal and inland wetlands in the more arid parts of Africa, central Asia and Europe. The Wadden Sea represents the north-western edge of their breeding range. About 13,000 pairs breed across the Wadden Sea area, which hosts more than half of the breeding pairs of the East Atlantic Flyway population (Hötter & West 2006). Generally, the vast majority breed in Schleswig-Holstein, where about 4,500 breeding pairs were recorded in 2006, compared with 5,460 in 2001 (Hälterlein unpubl. data; Koffijberg et al. 2006). In Niedersachsen, numbers are far lower, with c.2,000 breeding pairs in 2006, and 1544 pairs in 2001 (Table 3; Koffijberg et al. 2006). The Wadden Sea holds more than 95% of the German breeding population. Most colonies are situated on salt marshes next to estuaries or muddy bays on the mainland. Relatively few Avocets breed on the islands. Some of the recently embanked polders also hold high numbers of breeding pairs. The highest numbers are found in the salt marshes of Dithmarschen (Koffijberg et al. 2006). Some pairs nest on arable land close to the coast. In Germany this phenomenon mainly occurs on the coast of Dithmarschen. Usually, these colonies become established quite late in the season. It is not clear, therefore, whether these Avocets are late breeders or birds relaying after having lost their first clutches. The breeding success of Avocets depends to a great



extent on the weather. Clutches laid on salt marshes are at risk of being inundated by storm tides, and the survival rate of chicks is directly correlated with temperature in June. Adults raising their chicks in polders without access to tidal flats had lower breeding success than adults that could lead their chicks to tidal flats .

From very low numbers at the turn of the 19th and 20th century, the breeding Avocet population in Germany steadily increased until around 1990. In the following years population growth levelled off and the number of breeding pairs in the German Wadden Sea fluctuated around 6,000 – 7,000 pairs. Since 1996 numbers in Niedersachsen have sharply decreased, whereas the population in Schleswig-Holstein continued to grow slowly. Recent data indicate moderate decreases in Schleswig-Holstein and fluctuating numbers in Niedersachsen (Hälterlein; Südbeck unpubl. data). Avocets are not very faithful to their nesting sites, and colonies often change location between years. Some of the divergence in trends can possibly be explained by colony movements. The decline in Niedersachsen during the 1990s was greatly influenced by the trend at the largest colony in the Leybucht, which was much reduced following land reclamation and alterations to the hydrological regime.

Phenology in the German Wadden Sea, distribution and trend

After the breeding season, Avocet numbers increase dramatically in Niedersachsen, with a peak during October. Numbers drop sharply during November, and birds are virtually absent during the winter months. The spring peak is much less pronounced with more birds using the Wadden Sea of Schleswig-Holstein (Koffijberg et al. 2003; Blew et al. 2005a, b). During the non-breeding season there are considerable concentrations of moulting birds in the German Wadden Sea, particularly in the Jadebusen in Niedersachsen. Birds mainly occur on salt marshes, with many fewer at inland sites (Koffijberg et al. 2003). As in the breeding season, non-breeding birds prefer to forage and rest in muddy bays and estuaries such as the Eider and Elbe (mainland coast of southern Dithmarschen), as well as the Jadebusen and Dollart. The non-breeding population has experienced strong declines in recent years, particularly during the moulting season (Blew et al. 2007). A possible explanation for these declines might be the increasing number of Peregrines in the German Wadden Sea, which many Avocets might try to avoid.

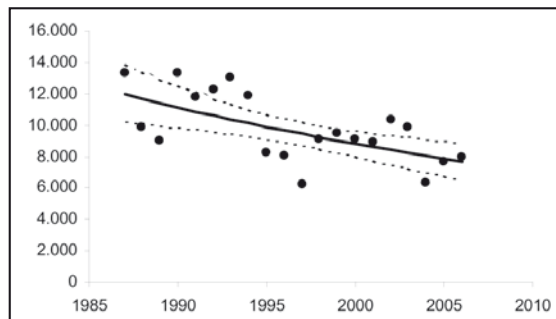


Fig. 16: Population trend of the Avocet in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

It is not known whether birds that start breeding at the mainland coast late in the season have lost clutches elsewhere, or if they are simply late breeders. As Avocets are not very site faithful, the role of displacement needs to be investigated more closely, in order to allow more reliable information on population development and to understand possible reasons for the switch of breeding sites. The impact of predators on resting and breeding individuals needs to be elucidated. At present, it is not known why numbers of Avocets during the moulting season are so low. Information on the selection of moulting sites needs to be collected. Avocets rely heavily on small crustaceans such as the mudshrimps (*Corophium* sp.), and so the role of these food stocks should be investigated.

Conservation actions

At present, birds that nest in safe locations, close to estuaries or muddy bays with suitable feeding grounds for the chicks exhibit the highest breeding success rates. Safe nesting sites are small islands in inland water bodies (often disused clay pits) close to the tidal flats. In many places, such habitats do not exist. If populations decline, new nesting sites could be established at suitable locations . These nesting sites would require some management, because newly created inland wetlands tend to become overgrown and thus unsuitable for Avocets after a few years. As Hötter & Segebade (2000) demonstrated, Avocets have direct access for their chicks to the tidal flats have a higher breeding success compared to other individuals. However, in many coastal regions of the German Wadden Sea, the access to tidal flats is not possible for chicks, due to insuperable coastal defence measures. The design of many coastal constructions such as giant loose boulders etc. should be altered to allow chicks access to their foraging habitat.

Ringed Plover *Charadrius hiaticula*

Status: breeding, passage/wintering

Global breeding range and populations

Two subspecies with different moulting periods are recognised: (1) *Charadrius hiaticula hiaticula* breeding from south Scandinavia through Iceland to Greenland and north-east Canada; and (2) *C. h. tundrae* which occurs from north Scandinavia to Siberia (Bauer et al. 2005a). The European breeding population holds 120,000 – 220,000 pairs (BirdLife International 2004). In Germany, Ringed Plovers breed on the Baltic coast and in the Wadden Sea, and are also present during the non-breeding period in high numbers. The species can also be found inland, but it becomes scarcer further south (Bauer et al. 2005a). The world population consists of more than 360,000 birds; the *hiaticula* population, to which the breeding birds of the Wadden Sea belong, is currently estimated to be 73,000 individuals (Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trend

Ringed Plovers breed in many parts of the Wadden Sea. It is by far the most important breeding area for the species in Germany. Smaller numbers can be found on the Baltic coast and scattered over a few inland sites. Ringed Plovers occur on the islands, on the Halligen where quite high concentrations can be found, and also on mainland salt marshes and in polders, which hold relatively high populations. Ringed Plovers prefer open ground, or salt marshes and meadows with a very short sward for nesting. In 2006 the German breeding population was about 460 pairs, with c.280 pairs breeding in Schleswig-Holstein (Hälterlein unpubl. data) and 180 pairs in Niedersachsen (Table 3). In 2001 the population in the German Wadden Sea was c.700 pairs (Koffijberg et al. 2006), so the strong declines that started in the 1990s (Hälterlein et al. 2000) have continued. The species was rather numerous in Schleswig-Holstein during the 19th century (Glutz v. Blotzheim et al. 1999). During the 1920s and 30s, the German breeding population increased and extended its range as far south as Belgium (Bauer et al. 2005a). Since the early 1990s, numbers of Ringed Plovers breeding in Germany have gone down steadily, both in Niedersachsen and in Schleswig-Holstein (Hälterlein et al. 2000). Over that time, the population has declined to less than half its 1990 size (Koffijberg et al. 2006). The likely reasons for this population decline, which has also been observed in other European countries, are habitat loss and disturbance. Ringed Plovers often nest on beaches, where

they are in danger of being displaced by tourists. Habitat has definitely been lost from the conservation polders, which had offered very attractive breeding sites in the years immediately following the land claims, but which have lost much of their attractiveness due to vegetation growth and increased risk of predation.

Phenology in the German Wadden Sea, distribution and trends

After the breeding period, numbers in the German Wadden Sea increase dramatically – consisting mainly of birds from the *tundrae* population – and reach a peak during August, with numbers fairly evenly split between Niedersachsen and Schleswig-Holstein (Koffijberg et al. 2003; Blew et al. 2005a, b). From November to February, numbers in the Wadden Sea are considerably lower, but build up again during March due to an influx of birds of the *hiaticula* population. A major peak occurs during late May, made up of the *tundrae* population, with the vast majority of birds occurring in Schleswig-Holstein and particularly on the Friedrichskoog peninsula (Blew et al. 2005b). During the non-breeding period, Ringed Plovers are widely dispersed over the whole Wadden Sea, but with hot-spots on the salt marshes of Dithmarschen and in particular on the sandy beaches of the island of Trischen (Koffijberg et al. 2003). Numbers during both autumn and spring migration have increased (although not significantly) in recent years (Blew et al. 2007).

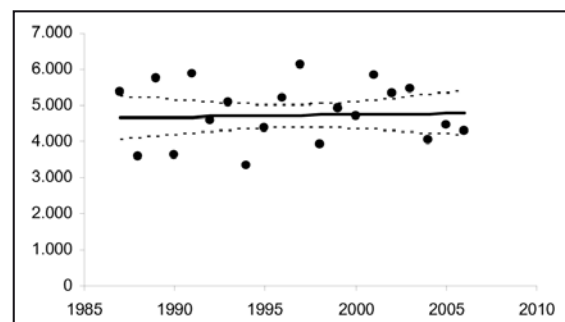
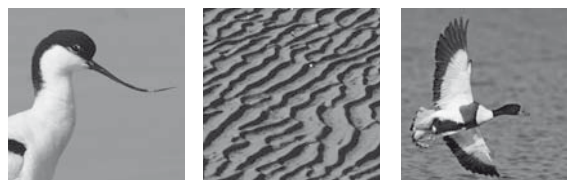


Fig. 17: Population trend of the Ringed Plover in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

Reasons for the decline of the breeding population are poorly understood. Relevant data on reproductive output and survival rates are not available for the German Wadden Sea. As there are declines at a population level throughout Europe, a study is needed which elucidates population dynamics on a larger spatial scale, in order to put the German Wadden Sea decline into an interna-



tional context. In addition, basic studies on the foraging ecology of this species, which might help to explain distribution and temporal patterns, are urgently needed.

Conservation actions

A population study should be started in order to understand the species' population dynamics (at different spatial scales). Ringed Plover breeding habitat has to be only sparsely vegetated. Management measures should aim to restore suitable breeding sites in order to stop the decline in breeding numbers in the German Wadden Sea. Breeding Ringed Plovers do not cluster, but instead breeding sites are dispersed over wide areas. This makes protection of sites (e.g. on sandy beaches) very complicated. However, core areas should be identified and public access should be prohibited, as Ringed Plovers are very susceptible to disturbance during the breeding period. Current visitor management on sandy beaches and primary dunes is inadequate.

Kentish Plover *Charadrius alexandrinus*

Status: breeding, passage

Global breeding range and populations

There are five or six subspecies of the Kentish Plover worldwide, three of them occurring in the Old World: (1) *Charadrius alexandrinus alexandrinus* breeding in Europe, north Africa and in the eastern Palearctic, (2) *C. h. dealbatus* in China and Japan and (3) *C. h. seebohmi* in Sri Lanka and south-east India (Bauer et al. 2005a; Delany & Scott 2006). These three subspecies breed from coastal Europe to north Africa and the steppes of central Eurasia. The species is widespread in central Europe, with high numbers in the coastal regions of the North Sea, and another major concentration in southern Europe. At the beginning of the 20th century, the population was already in decline (Glutz v. Blotzheim et al. 1999). In recent years, considerable declines in breeding numbers have been reported, particularly in Spain and Turkey (BirdLife International, 2004). The European breeding population comprises around 22,000 – 35,000 pairs (BirdLife International 2004). The Old World population consists of more than 269,000 birds, while the New World subspecies make up only a few thousand individuals. The population breeding in the east Atlantic and west Mediterranean holds c.62,000 – 70,000 birds (Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trends

Kentish Plovers breed in open areas and generally prefer sandy ground such as beaches, primary dunes and shell banks. They breed on the islands as well as on the mainland. In 2006, Schleswig-Holstein supported a breeding population of c.180 pairs (Table 3) compared to 162 in 2001 (Koffijberg et al. 2006). In Niedersachsen, the breeding population steadily decreased from 40 pairs in 2001 to only 18 pairs in 2006 (Koffijberg et al. 2006). The most important breeding aggregation of Kentish Plovers is located in the salt marshes and beaches of the Eiderstedt peninsula, and in the coastal wetlands of Nordfriesland in Schleswig-Holstein (for more details see Koffijberg et al. 2006). Lower numbers breed on the sandy East Frisian Islands (Heckenroth & Laske 1997). Following the establishment of polders, and due to positive effects of certain human activities such as deposition of sand in spoil areas, breeding numbers in the German Wadden Sea increased regionally, particularly during the 1970s and 1980s (Hälterlein 1998). However, since the 1990s, the overall trend of the breeding population in the German Wadden Sea has been downward (Hälterlein et al. 2000; Koffijberg et al. 2006). This is most likely an effect of habitat loss due to natural succession in the newly reclaimed polders (e.g. Hälterlein 1998), as well as frequent flooding of coastal breeding habitats during the summer months in recent years. Increasing predation by mustelids, foxes and harriers, particularly in the Eiderstedt area during the 1990s (Hälterlein et al. 1998; Schulz 1998) might have caused low breeding success. Furthermore, disturbance mainly by tourists using beaches has led to breeding failures (Schulz & Stock 1992; Schulz 1998).

Phenology in the German Wadden Sea, distribution and trends

Numbers of Kentish Plovers in the Wadden Sea are also low during the non-breeding season. Numbers peak in the autumn at c.150-200 individuals (Blew et al. 2005b; Fig. 18). Most birds rest on sand flats, beaches or dunes, with a slightly smaller proportion of birds using salt marshes, but in Schleswig-Holstein inland sites are also used (Koffijberg et al. 2003). In many places, resting and breeding sites are identical - or at least, around 95% of non-breeding birds remain in SPA zones (Koffijberg et al. 2006). Between November and February there are virtually no birds in the German Wadden Sea. Numbers increase rapidly again during April, although numbers during this period are much lower than in autumn (Blew et al. 2005b). The majority of the birds stay in Schleswig-Holstein (Koffijberg et al. 2003; Blew et al. 2005b). The

population trend shows long-term decreases (Fig. 18). However, trends are not strong, due to uncertainties in the assessment of this species and low overall numbers (Blew et al. 1995a; 2007).

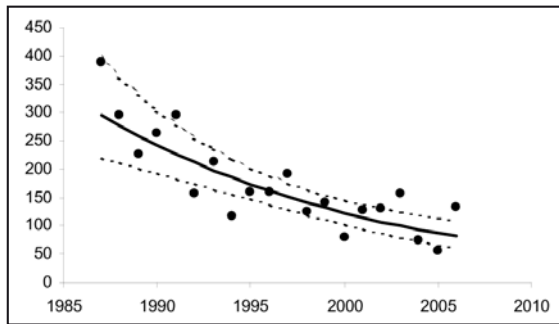


Fig. 18: Population trend of the Kentish Plover in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

Redistribution of breeding birds in the German Wadden Sea needs to be studied in detail. Moreover, habitat choice should be assessed in relation to hatching and fledging success. As clutches of Kentish Plovers are prone to predation, new studies on the impact of the increasing numbers of avian and mammalian predators need to be initiated; these should also consider the effect of different types of disturbance. Non-breeding numbers on the outer sands of the Wadden Sea are currently not known. Regular monitoring of such sites would improve the quality of monitoring data. As with the breeding population, relocations of resting and foraging non-breeding birds remain unclear. Studies of foraging ecology might help to explain distribution and temporal patterns, and are urgently needed, as there is almost no knowledge on this topic.

Conservation actions

Kentish Plovers need sparsely vegetated sandy habitats for breeding. Management measures should aim to restore suitable breeding sites in order to stop the decline in breeding numbers in the German Wadden Sea. Compared with Ringed Plovers, Kentish Plovers cluster slightly more at their breeding sites, which allows moderately better protection measures (for instance on the Eiderstedt peninsula and in conservation polders). However, there is probably a need for additional protected sites that are not at risk of flooding. Disturbance during the breeding period may lead to severe effects (Schulz & Stock 1992, Schulz 1998). Thus, greater effort is needed to reduce disturbance particularly by tourists. Visi-

tor management on sandy beaches and primary dunes is currently inadequate. Fencing to protect important breeding sites against mammalian predators could be beneficial.

Eurasian Golden Plover *Pluvialis apricaria*

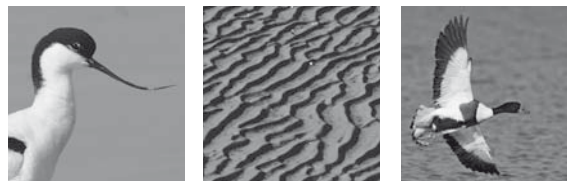
Status: passage/wintering

Global breeding range and populations

There is some uncertainty about the division of the species into subspecies. Until recently, the Eurasian Golden Plover was commonly separated into the subspecies *Pluvialis apricaria apricaria* (more southerly breeders in Europe) and *P. a. altifrons* (rest of Europe). However, according to Bauer et al. (2005a) the Golden Plover is now classified as a monotypic species. The Eurasian Golden Plover breeds in a large range from Iceland through Great Britain and Ireland to central Siberia. The Eurasian breeding population comprises about 460,000 – 740,000 pairs; declines since the 1990s in Great Britain and Sweden have been offset by increasing numbers in Finland (BirdLife International 2004). The global population is estimated to be more than 1.5 million birds (Delany & Scott 2006). Having once been more numerous and widespread across the lowland area of Niedersachsen, today only a few pairs breed regularly, in three bog-systems; the strong declines were caused by destruction of breeding habitat (Heckenroth & Laske 1997; Zang et al. 1995).

Phenology in the German Wadden Sea, distribution and trends

Numbers in the Wadden Sea are at their lowest during late May to early June; they increase rapidly from August and stay high until the end of November, when a peak is reached (Blew et al. 2005a, b). Hötker (2004) estimated a population size of 213,193 Golden Plover throughout Germany in October 2003, with the majority being located in Schleswig-Holstein. Depending on winter temperatures, many birds leave the Wadden Sea before numbers build up again in March, when another peak is reached with considerable numbers in particular in Schleswig-Holstein (Blew et al. 2005a, b). In Niedersachsen, high tide counts have shown that a considerable proportion of Golden Plovers rests on grassland and arable land adjacent to the Wadden Sea, while in Schleswig-Holstein large numbers use mainland salt marshes (Koffijberg et al. 2003). However, a study that also sampled inland sites showed a large proportion of birds (not recorded during high tide roost counts) using



arable fields, at least in Schleswig-Holstein (Hötger 2004). In August, many birds evidently use the tidal flats for foraging, with birds switching to inland sites from September onwards, showing a diurnal activity pattern (Ketzenberg & Exo 1996). The highest numbers at the coast can be found in polders on the Eiderstedt peninsula, at the mouth of River Elbe and on several islands such as Sylt and Amrum (Koffijberg et al. 2003). Golden Plover numbers show a long-term decline in the German Wadden Sea (Blew et al. 1995; 2007; Fig. 19).

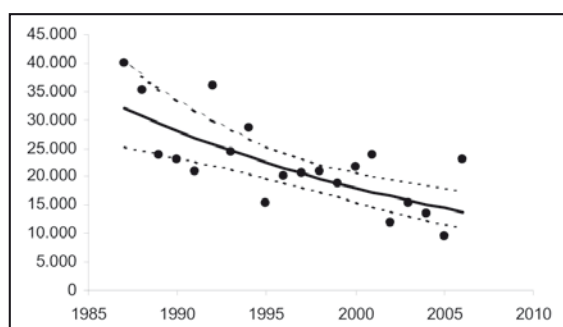


Fig. 19: Population trend of the Eurasian Golden Plover in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

Large flocks of Eurasian Golden Plovers occur at inland sites (e.g. Hötger 2004), which are not sufficiently monitored by the current schemes. It is important to know how many birds use inland sites further away from the Wadden Sea, and how they also use resting and foraging sites in the Wadden Sea. This would make calculations of the trends of non-breeding numbers more reliable. Also, temporal patterns in the distribution of mainland flocks should be investigated. Details on the foraging ecology of this species during the non-breeding period are not well known, although it may be possible to explain shifts from tidal flats to inland sites and general temporal patterns.

Conservation actions

Hunting of Eurasian Golden Plovers is still allowed in many European countries (e.g. France, Denmark, Poland, Italy), but it should be prohibited by law as a matter of urgency. Agricultural intensification and drainage of suitable foraging areas at mainland sites that are regularly used by Golden Plovers can result in loss of food (Barnett et al. 2004, Butler & Gillings 2004, Chamberlain et al. 2000, Vickery et al. 2001). Providing additional inland wetland areas in the inland that can be used by Golden Plovers as alternatives to salt marshes in the Wadden Sea might improve the situation for non-breeding birds.

Grey Plover *Pluvialis squatarola*

Status: passage/wintering

Global breeding range and populations

This monotypic species breeds from the eastern shore of the White Sea through north-east Siberia to arctic North America. Several authors split the Grey Plover into three subspecies (Bauer et al. 2005a). The European breeding population is only 2,100 – 11,000 pairs, all of which are located in the European part of Russia and for which no trend estimates are available (BirdLife International 2004). The world population holds approximately 557,000 birds, 247,000 of which use the East Atlantic Flyway (Delany & Scott 2006).

Phenology in the German Wadden Sea, distribution and trend

Autumn migration starts at the end of July and reaches a peak in late August. Wintering numbers depend on winter temperatures and have increased in recent years (Blew et al. 2005a, b). Spring migration starts in April and peaks in May, with numbers dropping sharply during June (Blew et al. 2005b). Throughout the year, Grey Plovers are spread evenly between Niedersachsen and Schleswig-Holstein (Koffijberg et al. 2003; Blew et al. 2005b). Immature birds regularly summer in the Wadden Sea (Meltofte et al. 1994). Most birds use salt marshes as high-tide roosts, with some also on sand flats. The most important resting sites are located on islands such as Spiekeroog, Scharhörn Sand and Trischen (Koffijberg et al. 2003). The vast majority of birds use SPA sites for resting. During the 1990s Grey Plovers showed substantial decreases in all peak months (Blew et al. 2005a). The longer-term trend for this species seems to be stable or slightly increasing (Blew et al. 2007).

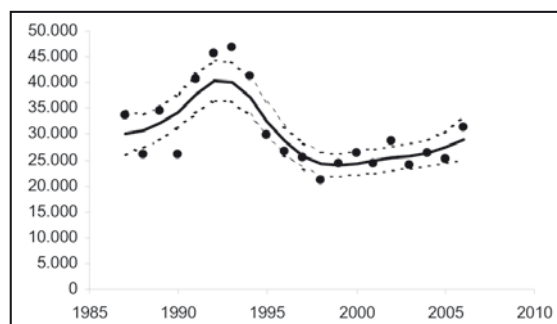


Fig. 20: Population trend of the Grey Plover in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

It is not currently known how many birds roost on the outer sands or on higher tidal flats that remain unsubmerged for long periods of time. Regular monitoring of such sites would improve the quality of monitoring data. Basic knowledge of the foraging ecology of Grey Plovers is lacking. Studies on this, in combination with assessment of the prey stocks would be needed to evaluate the quality of foraging and resting sites in the Wadden Sea, and help to explain distribution and temporal patterns. Currently it is not clear to what extent Grey Plovers are disturbed by avian predators, and whether predators might affect the quality of sites. The energetic constraints of such disturbances on this long-distance migrant should be clarified.

Conservation actions

Currently no conservation measures seem to be necessary, which might, however, be a result of an insufficient knowledge of basic ecological requirements of this species (see gaps in knowledge).

Northern Lapwing *Vanellus vanellus*

Status: breeding, passage/wintering

Global breeding range and populations

The Northern Lapwing is a widespread monotypic species that breeds in large numbers within the temperate and Mediterranean zones, from western Europe through north Africa to central Asia (Bauer et al. 2005a). The highest densities are found in the lowland landscapes of the Netherlands, northern Germany (e.g. Berndt et al. 2003; Heckenroth & Laske 1997), Poland and Russia. Its European breeding population is estimated at 1.7 – 2.8 million breeding pairs, with a dramatically downward population trend over almost the whole continent since the 1990s (BirdLife International 2004). The global population is estimated to be 5.2 – 9.5 million birds, with around 5.1 – 8.4 million belonging to the distinct population of Europe, Asia Minor and North Africa (Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trend

The Northern Lapwing is very numerous and widely distributed all over the Wadden Sea area. The highest breeding numbers are found particularly in Schleswig-Holstein, where a total of c.4,500 pairs was recorded in 2006, compared with c.4,300 pairs in 2001. In Niedersachsen 2,265 breeding pairs were found in 2006, com-

pared with c.2,100 pairs in 2001 (Table 3; Koffijberg et al. 2006). Clutches are generally laid in coastal grasslands with short (grazed) swards, while salt marshes and dunes or beaches are also used, but to a far lesser extent (Koffijberg et al. 2006). During the 1990s, numbers of Northern Lapwings along the North Sea coast decreased significantly (Hälterlein et al. 2000). However, trends varied between different habitat types: on the islands, significant increases were observed, whereas significant declines were recorded in the clay marshes behind the seawall on the mainland (Hötker et al. 2007). During the 1980s, densities of five breeding pairs per 10 ha were observed in several places in Schleswig-Holstein, whereas during the 1990s a density of 0.5 breeding pairs per 10 ha was common (for more details see Berndt et al. 2003). The conservation polders in Schleswig-Holstein also followed the negative trend in breeding numbers during the 1990s (Hötker et al. 2001).

Phenology in the German Wadden Sea, distribution and trend

During the non-breeding season, the Wadden Sea is nothing like as intensively used by Northern Lapwings as mainland sites. Thus, phenological patterns and trends of non-breeding numbers using Wadden Sea habitats are not reliable, as this species commutes between foraging and resting sites on the mainland according to meteorological conditions and food availability. However, numbers start to rise in early July and reach a peak in November, with most birds recorded in Schleswig-Holstein (Blew et al. 2005a, b). The lowest numbers are recorded during January, although some birds are usually present throughout the whole winter. Peak numbers on spring migration occur in March, but the spring peak is much smaller than in autumn (Blew et al. 2005a, b). Numbers of Northern Lapwing have fluctuated in recent years but the trend is calculated as stable (Blew et al. 1995; 2007; Fig. 21).

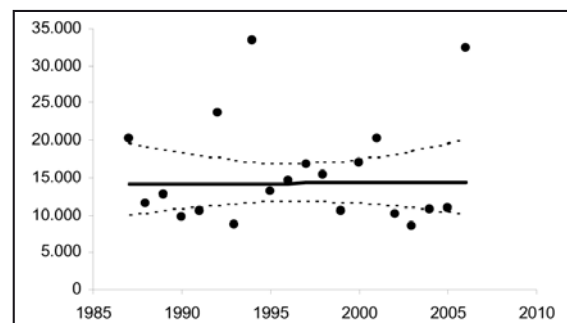
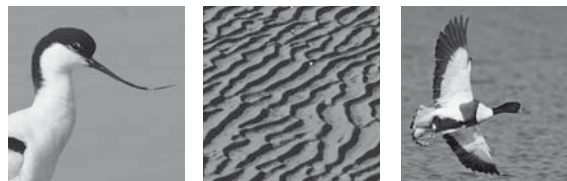


Fig. 21: Population trend of the Northern Lapwing in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.



Gaps in knowledge

The role of predation, particularly in mainland breeding habitats adjacent to the Wadden Sea, is not fully understood. There is a need to investigate the patterns and reasons for shifts from breeding sites and inland resting sites to tidal flats. The influence of land use and agricultural practices on breeding success and in particular on chick mortality needs further research.

Conservation actions

Although Northern Lapwings tolerate agricultural intensification more than other waders, intensification for hay, silage and corn production has led to a reduction of (wet) pastures and a reduced proportion of grazed land, and is the main reason for the deterioration of inland breeding and resting habitats. Agri-environment schemes targeted at extensive grazing should be set up in order to restore habitat quality for Lapwings. Farming activities must be timed according to the hatching of chicks in order to prevent chick mortality and enhance breeding success (no disturbance between 15th March to 15th June; Zang et al. 1995). Breeding areas should be kept free of structures such as dams, trees and bushes that provide cover for predators. Ground predator control might become necessary, at least in core breeding areas.

Red Knot *Calidris canutus*

Status: passage/wintering

Global breeding range and populations

Five subspecies of the Red Knot are recognised: (1) *Calidris canutus canutus* breeding on the Taimyr peninsula and Severnaya Zemlya; (2) *C. c. rogersi* (synonym “*piersmai*”) in the far north-east of Russia, and the New Siberian Islands; (3) *C. c. roselaari* in north-east Siberia and north-west Alaska; (4) *C. c. islandica* on the Canadian arctic islands and Greenland; and (5) *C. c. rufa* breeding in the Canadian low Arctic (Bauer et al. 2005a). Two of these five populations, *C. c. canutus* (comprising 400,000 individuals) and *C. c. islandica* (comprising 450,000 individuals) visit the Wadden Sea (Meltofte et al. 1994; Delany & Scott 2006). The European breeding population (mainly Greenland) consists of 15,000 – 30,000 breeding pairs (BirdLife International 2004). In contrast to the small breeding population, wintering numbers in Europe are high, but have suffered some local declines particularly in the United Kingdom (BirdLife International 2004) and the western Dutch Wadden Sea (Kraan et al. 2009). The global population of Red

Knot is estimated at more than 1.5 million birds (Delany & Scott 2006).

Phenology in the German Wadden Sea, distribution and trends

The *islandica* subspecies is most numerous in the German Wadden Sea on migration, though smaller numbers of birds overwinter, while the *canutus* subspecies uses the Wadden Sea only as a staging area en route to wintering grounds in west Africa. Most Red Knots in the German Wadden Sea can be found in Schleswig-Holstein (Koffijberg et al. 2003; Blew et al. 2005b). Knots feed almost entirely on shellfish in the Wadden Sea, using *Macoma balthica* as major food source, particularly on the tidal flats of Schleswig-Holstein (Leyrer, pers. comm.). Numbers start to build up in late July, reaching peak numbers during September. From October to January, numbers are low, but nevertheless several thousand birds winter in the German Wadden Sea. In late January, numbers start to increase again, peaking during April and May (Koffijberg et al. 2003; Blew et al. 2005a, b). Knots prefer to roost in large flocks on sand flats (e.g. Süderoogsand, Norderoogsand and Blauortsand) and to a lesser extent on salt marshes (Koffijberg et al. 2003). As these sand flats are often located far away from the mainland dyke, many flocks are not sampled during the high tide roost counts. This increases the variability of the data. However, population declines in the 1990s during both spring and autumn migration in the German Wadden Sea seem to be well founded (Blew et al. 2005b). Trend estimates for Germany are dominated by developments in Schleswig-Holstein. Long-term estimates showed a clear downward trend of the Knot population in the German Wadden Sea (Blew et al. 2007; Fig. 22).

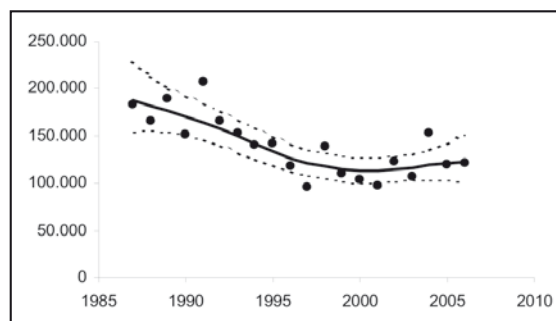


Fig. 22: Population trend of the Red Knot in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

As Red Knot depend entirely on shellfish, declines in the non-breeding population in the German Wadden Sea might be connected to shellfish stocks (Scheiffarth & Frank 2005). Thus, there is an urgent need to assess the relationships between Red Knots and their food stocks in the German Wadden Sea. In this context, analyses of the benthos are urgently required, to allow conclusions to be drawn about the availability and quality of prey available to Red Knots. As with other species using such habitats, there is a need to evaluate the role of the outer sands and tidal flats that are only occasionally flooded as foraging and resting sites for Red Knots. Regular counts of these areas would enhance the quality of the high tide roost data, which are mainly gathered from the mainland and islands. The role of disturbance from human activities and (avian) predators should be investigated.

Conservation actions

Strong flocking behaviour (flocks may consists of several thousands of birds) increases the impact of disturbance, as birds will take flight earlier. Recreational activities, military and civil aircraft and ships should be prohibited within the most important sites and during sensitive seasons. In the Netherlands, cockle dredging has been shown to have severe effects on knots (e.g. Kraan et al. 2009; Piersma et al. 2001; van Gils et al. 2006). The ban on this type of fishing the German Wadden Sea should be continued as a matter of importance.

Sanderling *Calidris alba*

Status: passage/wintering

Global breeding range and populations

The patchy, circumpolar breeding range of this monotypic species mainly includes the tundra zone of central Siberia, arctic North America, Greenland and Svalbard (Bauer et al. 2005a). The European breeding population shows a stable trend and holds only 25,000 – 50,000 pairs, mainly breeding on Greenland (BirdLife International 2004). The global population is estimated at more than 620,000 birds, with the East Atlantic Flyway supporting c.123,000 individuals (Delany & Scott 2006).

Phenology in the German Wadden Sea, distribution and trends

Sanderling can be found in the German Wadden Sea even during severe winters. During autumn migration (August to October with a slight peak during Septem-

ber) much smaller numbers are found than in spring (from April to June with a significant peak during May; Blew et al, 2005a,b). Except in winter, numbers are usually much higher in Schleswig-Holstein than in Niedersachsen (Koffijberg et al. 2003; Blew et al. 2005b). During the 1990s by far the most important resting sites were located on sand flats (in Schleswig-Holstein) and on beaches or dunes (in Niedersachsen) (Koffijberg et al. 2003). However, during recent years more birds switched to high-lying tidal flats e.g. in Dieksanderkoog in the southern part of Schleswig-Holstein, where several counts revealed thousands of birds during May (Blew et al. 2005b). Other very important sites are the island of Trischen, the inner Eider estuary and the sandy beaches of the Eiderstedt peninsula, as well as the outer sands of Schleswig-Holstein (Koffijberg et al. 2003). Sanderling have shown a significantly upward trend, at least for Schleswig-Holstein, although it is not entirely clear if these increases are due to improved counting schemes (Blew et al. 2005; 2007), as recent data analysis indicates a stable trend (Fig. 23).

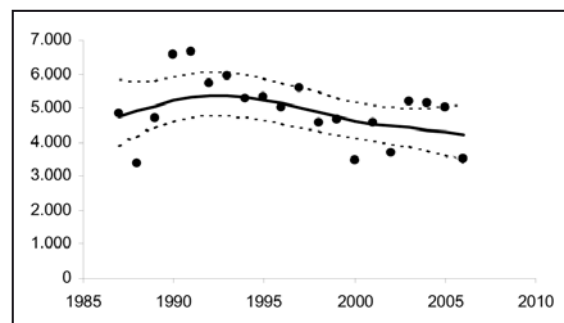
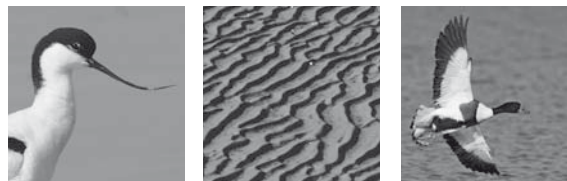


Fig. 23: Population trend of the Sanderling in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

As for other species using such habitats, there is a need to evaluate the role of the outer sands and tidal flats that are only occasionally submerged for foraging and roosting by Sanderling. Regular counts of these areas would improve the quality of the high tide roost data, which are mainly gathered from the mainland. The role of disturbance by human activities and avian predators should be investigated. There is a need to investigate the reasons for shifts from sandy resting habitats to tidal flats. There is an urgent need for basic studies on the foraging ecology of this species, which could help explain distribution and temporal patterns. Moreover, the effect of disturbance by natural avian and mammalian



predators should be clarified, in order to assess resting site quality.

Conservation actions

As around 99% of Sanderling in the German Wadden Sea stay within SPA boundaries (Koffijberg et al. 2003), direct negative effects due to anthropogenic activities should not be of crucial importance to this species. The availability of suitable resting sites might become more limited due to increased storminess as a result of climate change.

Curlew Sandpiper *Calidris ferruginea*

Status: passage

Global breeding range and populations

The Curlew Sandpiper is a monotypic species breeding in the arctic tundra of north Siberia (Bauer et al. 2005a). Apart from a few hundred birds in Iberia, this species winters in Africa, but considerable numbers occur on passage in the German Wadden Sea (BirdLife International 2004). Some of the most westerly flyway population (one of four) consisting of c.1 million individuals use the Wadden Sea as stop-over site (Bauer et al. 2005a; Delany & Scott 2006). The world breeding population is estimated to be more than 1.7 million birds (Delany & Scott 2006).

Phenology in the German Wadden Sea, distribution and trends

Only a very small proportion of the flyway population uses the German Wadden Sea. Peak numbers occur in July and August, with numbers decreasing rapidly until October, and the species is absent during the winter months. Small numbers can be recorded on return migration in May (Zeiske 1997; Blew et al. 2005a, b). Curlew Sandpipers are most frequent in the southern part of Schleswig-Holstein, mainly in the salt marshes of Dieksanderkoog, the outer Elbe estuary and around the Friedrichskoog peninsula, while they are virtually absent from Niedersachsen, apart from a few individuals (Koffijberg et al. 2003). Trend estimates are probably only approximate, as this species only occurs in a particular part of the Wadden Sea, which is hard to sample. In spite of this, the trend for the German Wadden Sea in recent years is upward (Blew et al. 2005; 2007).

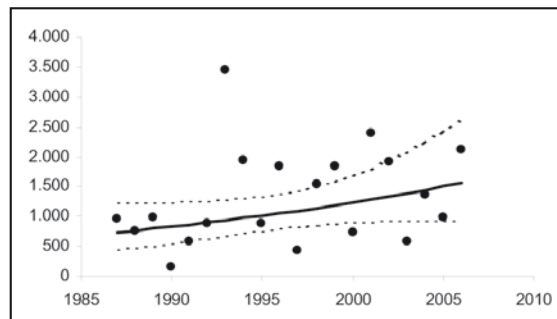


Fig. 24: Population trend of the Curlew Sandpiper in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

Currently it is not known why Curlew Sandpipers aggregate almost exclusively in the southern parts of Schleswig-Holstein. Basic studies on the foraging ecology of this species are needed to help explain distribution and temporal patterns. Moreover, the effect of disturbance by natural avian and mammalian predators should be clarified, in order to assess resting site quality.

Conservation actions

Disturbance to resting sites during the main migration period in July and August should be avoided. The availability of suitable resting habitat might become more limited, due to increased storminess as a result of climate change.

Dunlin *Calidris alpina*

Status: breeding, passage/wintering

Global breeding range and populations

Different authorities list between six and ten subspecies in the literature. For the Wadden Sea, the following are important: (1) *Calidris alpina alpina* breeding from north Scandinavia east to the Kolyma delta and occurring in the Wadden Sea in considerable numbers; (2) *C. a. schinzii* breeding in south-east Greenland, Iceland and west Europe (including a few breeding pairs in Germany) as well as central and south Scandinavia; (3) *C. a. arctica* breeding in north-east Greenland, which is a far rarer migrant in the Wadden Sea. The second two subspecies are uncommon in the Wadden Sea, as they migrate via Great Britain (Meltofte et al. 1994). A further three subspecies (*C. a. sakhalina*, *C. a. pacifica* and *C. a. arcticola*) breed in Siberia, Alaska and Canada and

do not occur in the Wadden Sea (for more details see Bauer et al. 2005a). The European breeding population of Dunlin consists of 300,000 – 570,000 pairs and declined significantly in eastern Europe (particularly around the Baltic Sea) during the 1990s (BirdLife International 2004). The world population consists of more than 4.6 million individuals, with the subspecies *alpina*, which is most important for the Wadden Sea, accounting for around 1.3 million (Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trends

The Dunlin breeding in the German Wadden Sea belong to the subspecies *C. a. schinzii*. They prefer to breed on sandy substrates with little vegetation. At the beginning of the 20th century, the Dunlin was a widespread and regular breeding bird throughout the lowland landscape of northern Germany (for details see Zang et al. 1995; Berndt et al. 2003). In recent years there have been no breeding records of Dunlin in the German Wadden Sea (Hälterlein; Südbeck, unpubl. data). In 2001, just two breeding pairs were found in the salt marshes of Eiderstedt in Schleswig-Holstein, which had been the most important site in Schleswig-Holstein for some years, but where numbers had been constantly declining (Koffijberg et al. 2006). In Niedersachsen, only single pairs were observed between 2000 and 2002 in the Dollart area (Staatliche Vogelschutzwarte im NLWKN, unpubl. data; Boschert 2005). During the 1960s, around 80 breeding pairs were recorded here (Hälterlein 1998). In previous years, numbers were similarly low, with several breeding records in the reclaimed polders of Nordfriesland, and on Trischen (Koffijberg et al. 2006). Numbers in the reclaimed polders had already shown dramatic declines during the early 1990s, probably as a result of natural successional vegetation growth (Hötker et al. 2001). But in other habitats too, Dunlin declined significantly during the 1990s (Hälterlein et al. 2000). The strong population decline in the German Wadden Sea is in line with the trend for the rest of Germany (Hötker et al. 2007) and Europe (Wetlands International 2004).

Phenology in the German Wadden Sea, distribution and trends

Dunlin is the most numerous species in the whole Wadden Sea. Up to 100% of the *alpina* subspecies can be found in the Wadden Sea during the migration period (Blew et al. 2005a). The influx of the birds into the German Wadden Sea starts in July, with numbers increasing rapidly in August and peaking in late September. Some individuals of the *schinzii* subspecies arrive as early as June (Meltofte et al. 1994). Over the whole autumn

migration, by far the largest numbers occur in Schleswig-Holstein, while numbers there are much lower in winter, and at that time of year more or less similar to Niedersachsen (Blew et al. 2005b). Numbers increase again in late February, with a peak in early April. As on autumn migration, higher numbers can be recorded in Schleswig-Holstein (Blew et al. 2005a, b). Most resting birds use salt marshes, with smaller numbers on sandy habitats; the most important roosts are located in Dieksanderkoog, on the island of Trischen and on several outer sands (Koffijberg et al. 2003). At low tide, most birds can be found on low lying and rather muddy flats (Ens et al. 1993). Over the years, Dunlin have shown considerable declines during both spring and autumn migration periods, at least in Schleswig-Holstein, while significant increases were estimated for the Dutch Wadden Sea (Blew et al. 2007).

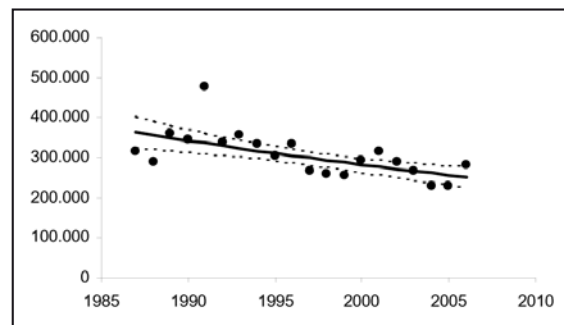


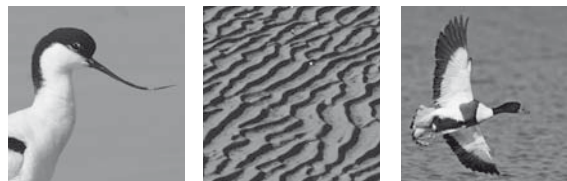
Fig. 25: Population trend of the Dunlin in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

Basic studies on foraging ecology are urgently needed in order to help explain distribution and temporal patterns. Moreover, the effect of disturbance by natural avian and mammalian predators should be clarified in order to assess resting site quality. There is a need to determine whether population trends are influenced by shifts in the phenology of this species, which should be considered in the context of climate change.

Conservation actions

To prevent the extinction of Dunlin as a breeding bird in the German Wadden Sea, breeding sites need suitable management measures to provide open areas with sandy soils and undisturbed nest sites. Potential breeding sites should be managed appropriately to enable re-settlement of breeding pairs. Measures include visitor management, maintaining high water levels and extensive grazing and ground predator control.



Ruff *Philomachus pugnax*

Status: breeding, passage

Global breeding range and populations

This monotypic species breeds from the coastal lowlands of north-west Europe and the taiga of east Europe, to the tundra zone of east Siberia (Bauer et al. 2005a). The European breeding population is 200,000 – 510,000 pairs and has been decreasing since the 1990s almost throughout Europe, but in particular in the most important breeding areas in Russia and Sweden (BirdLife International 2004). The global population is estimated to be more than 2 million individuals, with around 1 million using the East Atlantic Flyway and wintering in west Africa (Delany & Scott 2006). However, only a few thousand of these birds occur in the German Wadden Sea.

Breeding population size in the German Wadden Sea, distribution and trends

Ruff prefer wetlands, estuaries or river banks as breeding habitats (Hälterlein 1998). In line with the trend in the rest of Germany, breeding numbers in the German Wadden Sea are also strongly declining (Hälterlein et al. 2000). More than half of the German breeding population and around 80% of birds breeding in the whole of the Wadden Sea occur in Schleswig-Holstein. Most birds breed in the newly reclaimed polders in Nordfriesland, the Dithmarscher Speicherkoog and along the Eider estuary (Berndt et al. 2003; Koffijberg et al. 2006). Dramatic declines occurred as early as the 1970s, but in 1995 there was a further sharp decline in the breeding numbers at the Wadden Sea coast (Hälterlein et al. 2000). The total number of breeding pairs in Schleswig-Holstein in 2006 was estimated to be 12, compared with 27 pairs as recently as 2001 (Koffijberg et al. 2006). In Niedersachsen, just one pair was recorded breeding in the Hullen SPA (at the mouth of the Elbe) in 2006, while numbers in the same area were still as high as about 20 pairs in the late 1990s (Südbeck unpubl. data). In recent years, the pairs that remain have bred exclusively in protected areas (Heckenroth & Laske 1997). Successional vegetation growth in the conservation polders had already contributed to the decline during the 1990s, as most of the breeding population had switched to these areas in the years after the land was reclaimed (Hötker et al. 2001). For all of Germany, Hötker et al. (2007) identified a decline from 800 pairs in the early 1970s to just 10 pairs in 2004.

Phenology in the German Wadden Sea, distribution and trends

Only a small proportion of the flyway population uses the Wadden Sea. Ruff numbers in the German Wadden Sea start to build up in late June, and peak as early as the end of July. Numbers remain high until early September. From November to February most birds leave the Wadden Sea area, until an influx beginning in March, and reaching peak numbers during May (Blew et al. 2005a, b). In both spring and autumn, numbers in Schleswig-Holstein are considerably higher than in Niedersachsen (Blew et al. 2005 b). The most important resting sites are wet embanked areas behind the seawall. The population trend for Ruff in the German Wadden Sea over recent years is downwards (Blew et al. 2005; 2007; Fig. 26).

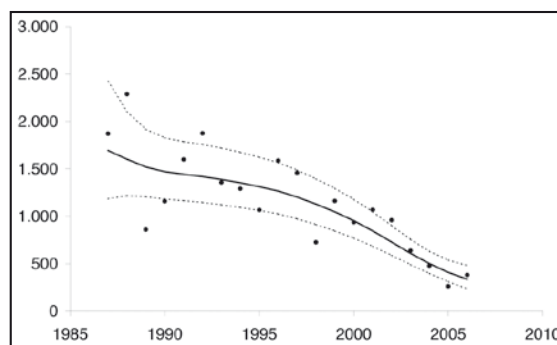


Fig. 26: Population trend of the Ruff in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

It is not known how much Ruffs use tidal flats during their stopover in the Wadden Sea, or to what extent they commute between foraging and resting sites in the Wadden Sea and on the mainland. In this context, detailed knowledge on the foraging ecology and prey choice of Ruffs in the Wadden Sea area is lacking. As Ruffs are highly susceptible to disturbance, the impact of disturbance of resting birds by mammalian and avian predators should be investigated. Survey effort has to be improved (better documentation of breeding sites and breeding success) to allow conservation measures to be implemented.

Conservation actions

To prevent the extinction of Ruff as breeding species both in Germany and on the Wadden Sea coast, there is an urgent need to protect and re-establish wet grasslands and temporarily flooded riverbanks. Agri-environment

schemes targeting extensive grazing should be set up in order to restore habitat quality for Ruffs. In order to prevent chick mortality and enhance breeding success, there is an urgent need for measures to regulate farming activities so that they are timed according to the hatching of chicks. Neither mowing nor grazing should start before 15th July. As Ruffs are very sensitive to disturbance, for example by tourists and farming activities, and may even abandon breeding attempts because of it (Zang et al. 1995), stronger protection of suitable sites is urgently required. Close protection of individual nests might be applied if considered necessary. Pesticide use should be reduced in preferred resting sites.

Bar-tailed Godwit *Limosa lapponica*

Status: passage/wintering

Global breeding range and populations

Two subspecies of Bar-tailed Godwits are generally recognised: (1) *Limosa lapponica lapponica* breeding from north Europe to east Siberia; and (2) *L. l. baueri* breeding from east Siberia to west Alaska. At present, several authors distinguish a further three subspecies (*L. l. taymyrensis*, *L. l. anadyrensis* and *L. l. menzbieri*) occurring in central and east Siberia (Bauer et al. 2005a). The European breeding population, which is mainly located in Scandinavia and Russia, comprises 1,400 – 7,400 pairs, and shows a stable trend except in Finland (BirdLife International 2004). The world population is around 1.1 million individuals, of which *L. l. lapponica*, many of which winter in the Wadden Sea, accounts for c.120,000 birds and *L. l. taymyrensis* 600,000 (Delany & Scott 2006).

Phenology in the German Wadden Sea, distribution and trend

L. l. lapponica winters in huge numbers in the German Wadden Sea, while smaller numbers of *L. l. taymyrensis* use the Wadden Sea only as stop-over site on their way to the wintering grounds in coastal west and south-west Africa (Bauer et al. 2005a; Delany & Scott 2006). For details on the migration patterns of these two populations occurring in the East Atlantic Flyway see Scheiffarth et al. (2002). Numbers of Bar-tailed Godwits start to increase during July, reach a slight peak during August and decline to their winter levels during November. Several thousand birds usually stay during the winter months (depending on temperatures), while numbers rise again during March, reaching an annual peak in May. Throughout the year, far more birds roost in Schleswig-

Holstein than in Niedersachsen (Koffijberg et al. 2003; Blew et al. 2005a, b). In contrast to autumn migration, birds seem to be highly site faithful in spring, and - assuming 100% site faithfulness - maximum annual mortality for adults in the Wadden Sea near Sylt and Rømø is between 17.4 and 26% (Scheiffarth 2001b). At high tide, most birds roost on salt marshes, though almost as many use sandy areas (Koffijberg et al. 2003). At low tide, sandy sediments are generally preferred (Ens et al. 1993). The highest high tide counts are made on Memmert and Lütje Hörn in Niedersachsen, and on Japsand, the island of Sylt and in the Elbe estuary in Schleswig-Holstein. Bar-tailed Godwit numbers show differing trends in different parts of the Wadden Sea: Schleswig-Holstein has shown a significant long-term decline, but the trend was stable for Niedersachsen and Denmark, while in the Netherlands there have been considerable increases (Blew et al. 2007; Fig. 27).

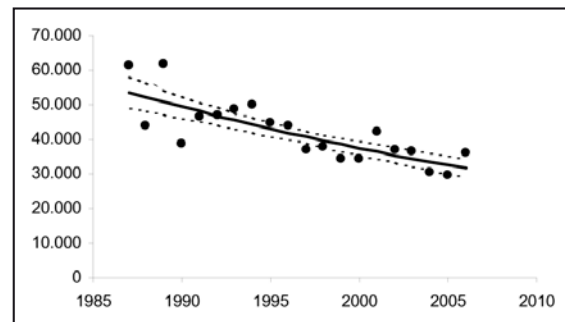


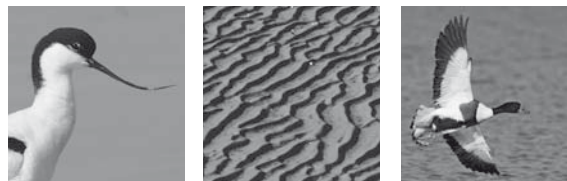
Fig. 27: Population trend of the Bar-tailed Godwit in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

Reasons for contrasting regional trends are not currently known. Reasons for the simultaneous declines in Schleswig-Holstein and increases in the Netherlands should be investigated. Although there is some basic knowledge about the foraging ecology of this species in the Wadden Sea (Scheiffarth 2001a), further investigations should be made into its distribution, behaviour and foraging ecology, against a background of locally declining numbers. In this context, information on the abundance, quality and availability on prey stocks is lacking. The role of disturbance caused by predators should be elucidated.

Conservation actions

As Bar-tailed Godwits gather in large flocks, they are vulnerable to human disturbance. Thus, resting sites



must be protected, particularly during the main migration period in August. The availability of suitable resting habitat might become more restricted due to increased storminess as a result of climate change.

Black-tailed Godwit *Limosa limosa*

Status: breeding, passage

Global breeding range and populations

There are three distinct subspecies of Black-tailed Godwits: (1) *L. l. islandica* breeding on Iceland, North Norway and Shetland and occurring in large numbers during migration at the German Wadden Sea coast; (2) *L. l. limosa* breeding in western Europe (including the Wadden Sea and adjacent mainland) as far as the Siberian river Yenisey; and (3) *L. l. melanuoides* breeding in distinct areas of eastern and central Siberia from the river Yenisey to eastern Asia (Bauer et al. 2005a). The European breeding population holds 99,000 – 140,000 pairs and has declined considerably since the 1970s. Although numbers have increased in some countries since the 1990s, the main populations in the Netherlands and Russia have shown further declines (BirdLife International 2004). The world population is estimated to be more than 634,000 birds, with the west European Flyway population consisting of 209,000 – 230,000 individuals (of which 162,000 – 183,000 belong to the *limosa* subspecies and 47,000 to the *islandica* subspecies; Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trends

Black-tailed Godwits breed throughout the German Wadden Sea, but mainly use the adjacent conservation polders and clay marshes of the mainland coast. There, a total of 62% of the German breeding population can be found. Only 6% breed on the Wadden Sea islands, a further 3% use the Wadden Sea salt marshes, and the remaining 29% use mainland sites, or sites on the Baltic coast (Hötcker et al. 2007). Niedersachsen holds by far the highest numbers of breeding birds in Germany, with most pairs using coastal sites on the mainland (Heckenroth & Laske 1997). Black-tailed Godwits prefer grassland areas with moderately high vegetation and low agricultural activity. In 2006, around 608 breeding pairs were recorded in the Wadden Sea of Schleswig-Holstein, compared with about 625 pairs in 2001 (Koffijberg et al. 2006). In Niedersachsen, the breeding population in 2006 was estimated at 737 pairs, and c.690 pairs in 2001 (Koffijberg et al. 2006). Important breeding areas

in recent years have been the estuaries of the Elbe, Eider and Ems, as well as polders such as the Dithmarscher Speicherkoog (Koffijberg et al. 2006). The breeding population for all of Germany was estimated to be c.14,000 pairs in the 1960s, but by the 1990s only 4,300 pairs remained (Hötcker et al. 2007). However, the overall trend for the Wadden Sea during the 1990s was stable (Hälterlein et al. 2000). Since the 1990s, significantly different trends in breeding numbers have been identified for different breeding habitats: on the North Sea islands numbers increased considerably, whereas everywhere else, including the newly reclaimed polders, the species showed significant declines (Hötcker et al. 2001; 2007).

Phenology in the German Wadden Sea, distribution and trends

Numbers of birds using the Wadden Sea during migration and winter are only low. Thus, population trends of non-breeding birds have not been estimated, as they have little statistical value. Spring migration throughout Europe is more pronounced than in autumn. Migration towards the wintering grounds starts as early as June, and peak numbers occur in August. During the migration period, large roosting flocks can be observed at undisturbed sites. During the winter, virtually no birds remain in the Wadden Sea area. Spring migration is also early, starting in February with peak numbers in March and April (for more details see Zang et al. 1995; Bauer et al. 2005a).

Gaps in knowledge

Reasons for the contrasting trends in different breeding areas must be studied. Black-tailed Godwits increased on the islands and declined at mainland sites, and so the role of predation should be evaluated. Furthermore, the contrasting trends should be investigated in the context of regional differences in prey availability and quality. Effects of predation and weather on breeding success and prey availability should be investigated.

Conservation actions

The overall declines in the German Wadden Sea are not as severe as at inland sites. In order to halt the declines, inland sites must be improved. Measures should include a reduction of grazing pressure, but also in particular water-logging measures, as Black-tailed Godwits are highly dependent on soft, wet soils for foraging. Breeding areas should be kept free of structures such as dams, as well as trees and bushes that provide habitat for predators. Agricultural practices should be timed to suit the requirements of Black-tailed Godwits, in order to avoid chick mortality and enable a higher breeding

success. Agri-environment schemes aiming at a more extensive agricultural practice on pastures are highly desirable. Ground predator control may be necessary, at least in core breeding areas.

Whimbrel *Numenius phaeopus*

Status: passage/wintering

Global breeding range and populations

Whimbrel breed from the taiga zone in north Eurasia to Alaska and Canada. Depending on the literature chosen, either four or five subspecies of the Whimbrel are recognised: (1) *Numenius phaeopus phaeopus* breeding from northern Europe to western Siberia; (2) *N. p. islandicus* in Iceland and northern Britain, which is often not recognised as an independent subspecies; (3) *N. p. alboaxillaris* breeding in the steppes region of the lower Volga area in Russia; (4) *N. p. variegatus* breeding in east Siberia; and (5) *N. p. hudsonicus* breeding in the Nearctic (Bauer et al. 2005a). The European breeding population is 160,000 – 360,000 pairs, with only small declines in Sweden and Finland (BirdLife International 2004). The world population is estimated at more than 1 million individuals. The population of Fennoscandia, the Baltic States, Greenland and north-west Russia uses the German Wadden Sea during migration and consists of around 190,000 – 340,000 birds (Delany & Scott 2006).

Phenology in the German Wadden Sea, distribution and trends

The most migrating Whimbrel pass through inland areas of Germany; however, several hundred birds use the Wadden Sea as a stop-over site. Birds arrive in the German Wadden Sea as early as July, and peak rapidly during late July and August. Numbers drop fast in October, and most birds leave the Wadden Sea during winter. Birds start to return again in March, and the spring peak is reached during May (Blew et al. 2005a, b). Although this species is very evenly distributed throughout the German Wadden Sea, the highest numbers in spring are recorded in Niedersachsen, and autumn numbers are higher in Schleswig-Holstein (Blew et al. 2005b). The main site is the Ems estuary (Koffijberg et al. 2003). Most birds roost on salt marshes at high tide (Koffijberg et al. 2003). Compared to non-breeding numbers at inland sites (where birds mainly use ponds and pastures; Zang et al. 1995), the numbers from the Wadden Sea are generally low. Inland sites are also used intensively for foraging. Numbers of non-breeding birds are probably too low to calculate reliable trends, but, there seems to

have been a long-term decrease in Whimbrel numbers, particularly in Niedersachsen (Blew et al. 2005; 2007).

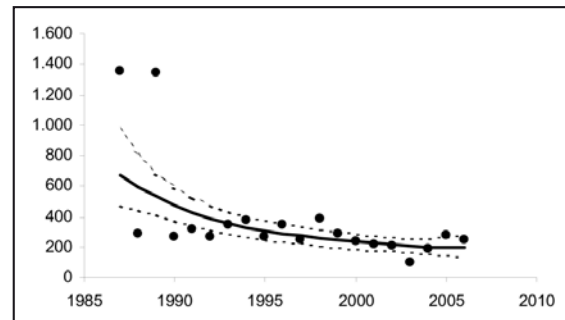


Fig. 28: Population trend of the Whimbrel in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

It would be very useful to know how many birds also use mainland sites further away from the Wadden Sea, and how they stay in contact with resting and foraging sites on the coast. This would make estimating trends of non-breeding numbers more reliable. Temporal patterns of mainland flocks should also be investigated. Details of the foraging ecology of this species during the non-breeding period are not known, but they might be able to explain shifts from tidal flats to inland sites and general temporal patterns.

Conservation actions

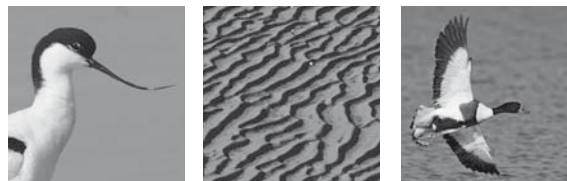
As more than 90% of all Whimbrel migrating through the German Wadden Sea spend their time in SPAs (Koffijberg et al. 2003), the protected area coverage for this species seems to be sufficient. However, habitat improvements at mainland sites, including water logging measures, and providing undisturbed and less-intensively used areas would be beneficial.

Eurasian Curlew *Numenius arquata*

Status: breeding, passage/wintering

Global breeding range and populations

The Eurasian Curlew is a widespread breeding bird of temperate and boreal zones from western Europe to eastern Siberia. There are two subspecies of the Eurasian Curlew: (1) *Numenius arquata arquata* breeding from Europe to western Siberia; and (2) *N. a. orientalis* occurring in western Siberia and further east. A third



form (*N. a. suschkini*) is not generally recognised as a separate subspecies (Bauer et al. 2005a). The European breeding population holds 220,000 – 360,000 pairs; in most countries of Europe declines that were first noted in the 1970s have continued, and key areas in Britain, Scandinavia and Russia show severe negative trends in breeding numbers (BirdLife International 2004). The East Atlantic Flyway population of Eurasian Curlew is estimated to hold c.700,000 – 1 million individuals (Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trends

Most (88%) of the German breeding population of Curlew occurs in inland areas, with a small proportion (9%) in the coastal lowland landscape of northern Germany, a further 3% on the North Sea islands and only very few pairs in the salt marshes of the mainland (Hötker et al. 2007; for further information on breeding distribution in northern Germany see Heckenroth & Laske 1995; Berndt et al. 2003). In the German Wadden Sea, birds are more or less restricted to the East Friesian Islands, where 114 pairs were recorded in 2006, indicating a stable trend. The highest numbers were found on Norderney, Borkum and Langeoog (Südbeck, unpubl. data). In contrast, there have usually been fewer than 5 breeding pairs in the Schleswig-Holstein Wadden Sea area in recent years, mainly in the dunes of the island of Amrum (Hälterlein, unpubl. data). Curlews prefer wet dune slacks and dune heath for breeding (Koffijberg et al. 2006). There are contrasting population trends, with the mainland showing significant declines, while there have been clear increases on the Wadden Sea islands (Hötker et al. 2007). Overall numbers in the Wadden Sea during the 1990s were stable (Hälterlein et al. 2000). This trend seems to have continued during recent years (Hälterlein; Südbeck unpubl. data). The German breeding population during the 1970s has been estimated to have been at least 7,000 pairs, compared with only 4,200 pairs in 2004 (Hötker et al. 2007). Declines were particularly strong in south and central Germany (Boschert 2005).

Phenology in the German Wadden Sea, distribution and trends

Throughout the year, far more birds can be found in the Niedersachsen Wadden Sea than in Schleswig-Holstein (Koffijberg et al. 2003; Blew et al. 2005b). Numbers are lowest during May and June. Following an increase in early July, numbers peak during August and September and remain quite high until late November. Numbers during the winter months are only slightly lower. There is

no noticeable peak during spring migration (Koffijberg et al. 2003; Blew et al. 2005a, b). Curlews in the Wadden Sea generally prefer low, muddy tidal flats for foraging (Ens et al. 1993). At high tide the vast majority of birds use salt marshes for roosting (Koffijberg et al. 2003). The highest numbers can be found on the East Friesian islands, as well as in the salt marshes of southern Schleswig-Holstein, and on the island of Trischen (Koffijberg et al. 2003). Curlews often commute between tidal flats and mainland resting sites (Gloe 1998; 1999), which increases the variability of the high tide roost data. It has been shown that Curlews in Denmark increased in numbers and altered their distribution pattern after hunting was banned (Laursen 2005). The trend of the non-breeding population in the Wadden Sea differs between regions: Schleswig-Holstein showed considerable long-term declines, whereas numbers have remained stable in Niedersachsen and increased in both Denmark and the Netherlands (Blew et al. 2007; Fig. 29).

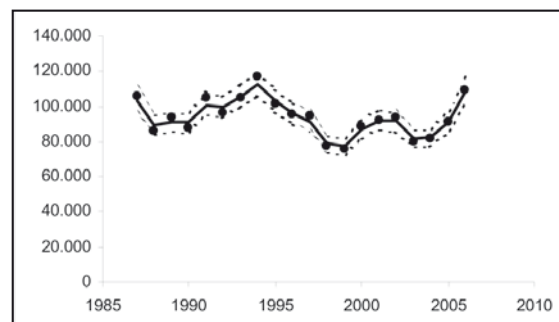


Fig. 29: Population trend of the Eurasian Curlew in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

Reasons for the contrasting trends between the mainland and in the Wadden Sea are unclear. Redistribution of breeding pairs from the mainland to the Wadden Sea islands should be studied. The foraging areas of birds breeding in the Wadden Sea are unknown. It is not currently known to what extent birds from the islands commute to mainland foraging sites. Spatial and temporal patterns of foraging ecology should also be studied, against the background of contrasting population trends in different areas of the Wadden Sea (Blew et al. 2007). In this context, the role of predation pressure is unknown. Investigation of non-breeding site quality in terms of predation pressure, vegetation structure and food availability/quality might assist an explanation of contrasting regional trends.

Conservation actions

In order to halt Curlew declines in mainland breeding habitats, water-logging measures, agri-environment schemes encouraging extensive land use and reduced grazing pressure, and reestablishment of bogs and fens are all urgently needed. Agricultural practices should be adjusted to suit the breeding phenology of Curlews, i.e. no mowing or other operations between mid-March and end of June (Zang et al. 1995). Water abstraction on dune islands should be restricted, in order to prevent further lowering of ground water tables and consequent deterioration of dune slacks. Curlews exhibit large flush distances at high tide roosts (Koffijberg et al. 2003). Therefore, human disturbance at the sites holding the largest flocks should be prevented.

Spotted Redshank *Tringa erythropus*

Status: passage

Global breeding range and populations

The Spotted Redshank is a monotypic species of the arctic and boreal zone; its breeding range extends from northern Norway and Finland to east Siberia, with a gap around the Taimyr Peninsula (Bauer et al. 2005a). The European breeding population holds 19,000 – 42,000 breeding pairs, but there have been declines since the 1990s, mainly in the key breeding area in Finland (BirdLife International 2004). The global population is estimated at more than 105,000 individuals; the population using the East Atlantic Flyway consists of 60,000 – 120,000 individuals (Delany & Scott 2006).

Phenology in the German Wadden Sea, distribution and trend

Numbers in the Wadden Sea begin to build up as early as late June. These birds are mainly females, while males and immatures follow a few weeks later, leading to an overall peak in numbers in August (Blew et al. 2005a). From then on, numbers decrease steadily until by late December virtually all the birds have left the Wadden Sea. Birds return again in early April and numbers reach a (much lower peak) during May (Koffijberg et al. 2003; Blew et al. 2005a, b). During autumn migration, most birds are found in the Schleswig-Holstein Wadden Sea (Koffijberg et al. 2003; Blew et al. 2005). At high tide most birds use mainland salt marshes, although a few birds in Schleswig-Holstein also use inland sites (Koffijberg et al. 2003). In Niedersachsen, the highest numbers can be found in the Dollart, while in Schleswig-

Holstein the salt marshes of the Elbe River estuary and the Dithmarscher Speicherkoog are most important (Koffijberg et al. 2003). The non-breeding population in Germany has shown declines since the 1990s in both migration periods; these have been particularly severe in Schleswig-Holstein (although the trend estimate for the whole Wadden Sea is stable; Blew et al. 2005; 2007).

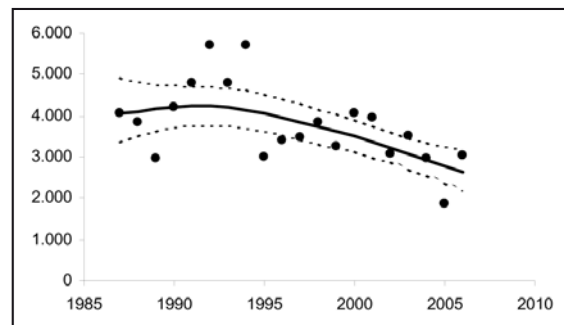


Fig. 30: Population trend of the Spotted Redshank in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

Reasons for contrasting regional trends are not currently known. There is only basic knowledge on the foraging ecology of this species in the Wadden Sea. Thus, further investigations should be started into the distribution, behaviour and foraging ecology of the species, against the background of locally declining numbers. In this context, information on the abundance, quality and availability on prey stocks is lacking. The role of disturbance caused by predators should be clarified.

Conservation actions

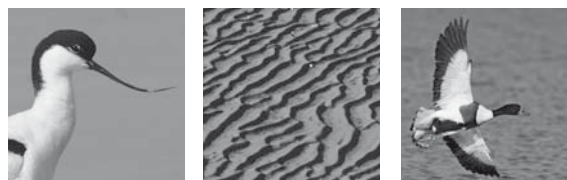
Restoration of wetland sites in the mainland would increase the extent of non-breeding habitat for this species in Germany, and could buffer against the effect of disturbance at the few existing passage sites.

Common Redshank *Tringa totanus*

Status: breeding, passage/wintering

Global breeding range and populations

Common Redshank has a very wide breeding range over much of Eurasia, from the Mediterranean to boreal zones, and in steppe and desert areas of Asia. There are six (or according to some authorities seven)



subspecies of Common Redshank: (1) *Tringa totanus robusta* breeding on Iceland and the Faroe Islands; (2) *T. t. totanus* from western Europe to the Urals; (3) *T. t. terrignotae* breeding in Manchuria and eastern China; (4) *T. t. ussuriensis* breeding from the Urals to northern Manchuria; (5) *T. t. craggi* breeding in China; and (6) *T. t. eurhinus* in the mountains of central Asia (Bauer et al. 2005a). Several authors also distinguish the subspecies *T. t. britannica* breeding in Britain and Ireland (Delany & Scott 2006). The European breeding population holds 280,000 – 610,000 individuals and started declining as early as the 1970s. In most countries of Europe, most notably in Great Britain and the Ukraine, the downward trend has continued (BirdLife International 2004). The global breeding population of Common Redshank is estimated at more than 970,000 individuals (Delany & Scott 2006). Birds of three subspecies occur in the Wadden Sea: (1) *robusta* (total subspecies population 150,000 – 400,000 individuals); (2) *totanus* (more than 273,000 birds) which occurs in the largest numbers during migration; and (3) *britannica* (more than 95,000 birds), which uses the Wadden Sea only in small numbers during winter (Meltofte et al. 1994; Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trends

Common Redshanks prefer tall salt marsh vegetation as breeding habitat (e.g. Thyen & Exo 2005; Thyen et al. 2005). Consequently, most breeding Common Redshanks in Germany can be found in mainland salt marshes and adjacent clay marshes (48% and 29%, respectively), while there are many fewer breeding pairs on the Wadden Sea islands (14%), or in the rest of the mainland and the Baltic Sea coast (Hötker et al. 2007; see also Koffijberg et al. 2006 and Hälterlein 1998 for a comparison of breeding habitats of the whole Wadden Sea and Schleswig-Holstein, respectively). The most important breeding sites are found in the Jadebusen, Leybucht and Dollart in Niedersachsen, and in the mainland salt marshes of Nordfriesland and Dithmarschen in Schleswig-Holstein (Koffijberg et al. 2006). The total Wadden Sea breeding population in 2001 was estimated at 15,000 pairs (Koffijberg et al. 2006). In 2006, 4,060 breeding pairs were recorded in Schleswig-Holstein, while there were 4,610 pairs in Niedersachsen. The biggest declines in breeding numbers since the 1990s have occurred at inland sites, while the strongest increase was found on mainland salt marshes (Hötker et al. 2007). This might be related to abandonment of grazing in salt marshes, which probably improved the breeding habitat quality for Redshanks considerably

(Hälterlein 1998; 2000). However, in the conservation polders successional vegetation growth does not seem to sustain higher breeding numbers, as nearly all of the polders show declining numbers of Common Redshanks (Hötker et al. 2001). A comparison of breeding success in the Jadebusen and on the island of Wangerooge showed lower breeding success on the mainland salt marshes compared with the island, as a consequence of predation (Thyen et al. 2008). The current reproduction rate in mainland salt marshes is considered to be insufficient to sustain the breeding population, in contrast to islands; this indicates source-sink population dynamics in the Wadden Sea (Thyen et al. 2005; Thyen et al. 2008). Overall, the population trend of Common Redshanks in the Wadden Sea area is stable (e.g. Thyen et al. 2005; Hötker et al. 2007).

Phenology in the German Wadden Sea, distribution and trend

Shortly after the breeding season, numbers in the German Wadden Sea increase dramatically in late July, and peak values for the whole year are reached at this early stage of the season. These birds are mainly from the *totanus* and *robusta* subspecies (Meltofte et al. 1994). In the following months, numbers decrease steadily, until in December the stable wintering population is reached. Spring migration is far less pronounced and has a slight peak during May (Koffijberg et al. 2003, Blew et al. 2005a, b). During autumn, similar numbers are found in both Schleswig-Holstein and Niedersachsen, while in winter and particularly in spring numbers are much higher in Niedersachsen (Blew et al. 2005b). At low tide, Common Redshanks mainly use sandy or muddy low-lying tidal flats (Ens et al. 1993). At high tide, most birds can be found on salt marshes (Koffijberg et al. 2003). Important roosts are located in Neufelderkoog at the mouth of the Elbe, as well as in the salt marshes between Neuharlingersiel and Dornumersiel, and at Norddeich and Neßmersiel (Koffijberg et al. 2003). Common Redshank have shown downward trends across the whole Wadden Sea over the last 20 years, although they have been stable for the last 10. Moreover, contrasting regional trends were found for numbers of roosting birds in different areas of the Wadden Sea: clear declines for Niedersachsen, but more or less stable trends for Schleswig-Holstein (Blew et al. 2007).

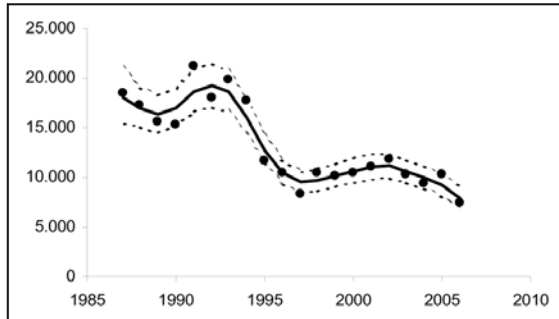


Fig. 31: Population trend of the Common Redshank in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

More detailed information on the population dynamics of Common Redshanks in the German Wadden Sea is needed, especially in the context of contrasting trends for different breeding habitats. There should be a larger scale investigation into source-sink mechanisms in population dynamics in the Wadden Sea and adjacent areas. In this context, the role of predation urgently needs to be further investigated. While there is substantial knowledge on breeding biology, and basic information on population dynamics, the foraging ecology of Redshanks in the German Wadden Sea has not yet been studied in any detail. There is also a need for studies into temporal and spatial patterns that might account for use of foraging habitat.

Conservation actions

Abandonment of grazing on (mainland) salt marshes has had positive effects on Common Redshanks and should therefore be maintained. Although the overall breeding success and breeding numbers in the Wadden Sea area are comparatively high, the dramatic declines at mainland sites in northern Germany need to be halted. Establishment of suitable agri-environment schemes would provide an important conservation tool. More extensive use of grassland sites, water-logging measures and the adjustment of agricultural practices (such as hay or silage making and application of fertilisers) to suit the breeding phenology of Common Redshanks are all urgently required. Breeding areas should be kept free of structures as dams, trees and bushes that provide habitat and cover for mammalian predators.

Common Greenshank *Tringa nebularia*

Status: passage

Global breeding range and populations

The Common Greenshank is a monotypic species breeding in the boreal zone of north Eurasia, Scotland and Scandinavia to the southern tundra zone of east Siberia and Kamchatka (Bauer et al. 2005a). The European breeding population is estimated at 75,000 – 160,000 pairs and stable (BirdLife International 2004). The global population is more than 440,000 individuals with the East Atlantic Flyway population consisting of 190,000 – 270,000 birds (Delany & Scott 2006).

Phenology in the German Wadden Sea, distribution and trend

Numbers of Greenshank start to increase in late July, reach a peak during late August and then decline, until virtually all birds have left the Wadden Sea by December. Return passage starts in April, reaching a much lower spring peak in May. During autumn, most birds are found in Schleswig-Holstein, while on spring migration the majority of birds are in Niedersachsen, with a spring peak almost absent in Schleswig-Holstein (Koffijberg et al. 2003; Blew et al. 2005a, b). Most birds roost on salt marshes, with many fewer at inland sites (Koffijberg et al. 2003). During migration this species can be found throughout the Wadden Sea and is much less concentrated than Common Redshank. The highest numbers are found in the Elbe estuary (Koffijberg et al. 2003). Common Greenshank rarely use mainland sites on migration. Most birds can be found throughout the Wadden Sea. The trend for non-breeding Greenshank in the German Wadden Sea has been more or less stable in recent years (Blew et al. 2005a; 2007; Fig. 32).

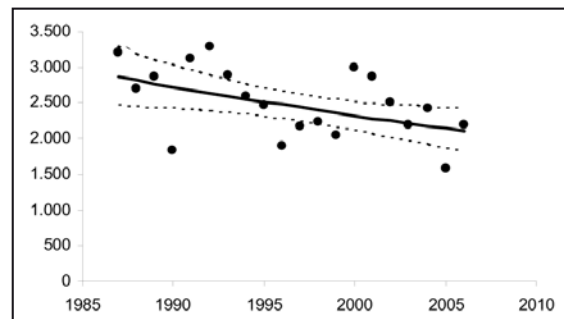
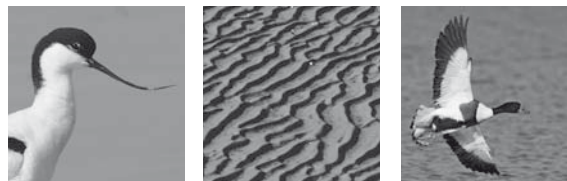


Fig. 32: Population trend of the Common Greenshank in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

There is only basic knowledge on the foraging ecology



of this species in the Wadden Sea. Thus, further investigations should be started into distribution, behaviour and foraging ecology. In this context, information on the abundance, quality and availability of prey stocks is lacking. The role of disturbance caused by predators should be clarified.

Conservation actions

About 95% of all birds use SPAs spread around the whole Wadden Sea (Koffijberg et al. 2003), which indicates good protected area coverage for the that non-breeding sites of this species. Furthermore, trends for this species are stable. However, due to a lack of basic knowledge of Greenshank ecology and to the short period of time that this species is present in the Wadden Sea, it is possible that not all necessary conservation actions have so far been identified. Disturbance during the short and intense migration period should be avoided. The availability of suitable resting habitat might become more limited, due to increased storminess as a result of climate change.

Ruddy Turnstone *Arenaria interpres*

Status: breeding, passage/wintering

Global breeding range and populations

Ruddy Turnstones have a circumpolar breeding distribution in the boreal, tundra and partly also the temperate zone. There are two subspecies: (1) *Arenaria interpres interpres* which breeds from Greenland, throughout the Palearctic to north Alaska; and (2) *A. i. morinella* breeding in arctic Canada (Bauer et al. 2005a). The European breeding population holds 34,000 – 81,000 pairs and is currently stable (BirdLife International 2004). The global population is estimated at more than 460,000 individuals (Delany & Scott 2006). Two populations can be found in the Wadden Sea: (1) The north-east Canadian and Greenland population (100,000 – 200,000 individuals); and (2) the Fennoscandian and north-west Russian population (45,000 – 120,000 individuals; Meltofte et al. 1994; Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trends

Turnstones reach the most southerly point of their world breeding range in Denmark and Northern Germany. Before the 1980s there was no evidence of breeding Turnstones on the German North Sea coast, but in 1982 the first breeding record was proved on the Eiderstedt peninsula (Struwe 1983). In recent years, Turn-

stones have regularly bred in very low numbers in the Schleswig-Holstein Wadden Sea area, but so far there have been no breeding attempts in Niedersachsen (Zang et al. 1995; Berndt et al. 2003). Turnstones generally use sandy habitats for breeding. Consequently, previous breeding records from Schleswig-Holstein come from the sandy beaches of Eiderstedt, Amrum, Föhr and Trischen (Berndt et al. 2003). However, during recent years several records have also come from some of the Halligen (such as Hamburger Hallig, Gröde, Südfall, Langeness). In 2006 there was just one record of breeding Turnstones on the Hallig of Gröde. Compared to the 1990s and the beginning of the new century, when 3-4 breeding pairs were regularly recorded at the Wadden Sea coast of Schleswig-Holstein (Berndt et al. 2003; Boschert et al. 2005), numbers have decreased during recent years, with only single pairs recorded since 2003 (Hälterlein unpubl. data).

Phenology in the German Wadden Sea, distribution and trends

Numbers of Ruddy Turnstones in the German Wadden Sea increase during late July and peak in September. Numbers decrease during November, but generally winter numbers are high, though depending on winter temperatures. During May there is an intense peak of spring migration, which is shorter but just as high as in autumn (Koffijberg et al. 2003; Blew et al. 2005a, b). In spring and autumn migration periods numbers are far higher in Schleswig-Holstein, in contrast to the winter months when most birds are present in Niedersachsen (Koffijberg et al. 2003; Blew et al. 2005b). High tide roosts may be located on artificial structures, but most birds rest on sandy ground or salt marsh; the most important roosting area in the German Wadden Sea is located on the island of Trischen (Koffijberg et al. 2003). The population trend of Turnstones during the last years is upward (Blew et al. 2005; 2007; Fig. 33).

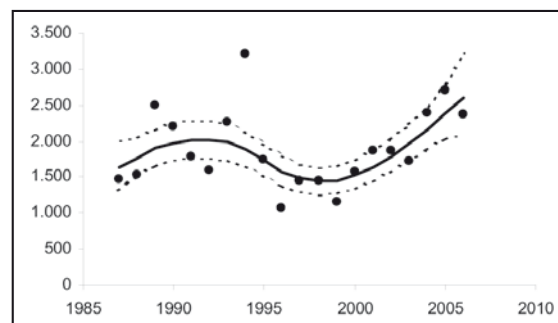


Fig. 33: Population trend of the Ruddy Turnstone in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

There is only basic knowledge on the foraging ecology of this species in the Wadden Sea. Thus, further investigations should be set up into distribution, behaviour and foraging ecology. In this context, information on the abundance, quality and availability on food stocks is lacking. The role of disturbance caused by predators should be clarified.

Conservation actions

Only about 85% of the total number of birds are found in SPAs, because a high proportion use artificial roost sites. However, Ruddy Turnstones seem to tolerate a high degree of human disturbance (Koffijberg et al. 2003). At present, there is no obvious need for conservation action, although this might partly be a result of a lack of knowledge of the ecological requirements of this species.

Black-headed Gull *Larus ridibundus*

Status: breeding, passage/wintering

Global breeding range and populations

The Black-headed Gull is a monotypic species that breeds in temperate regions from north-west and southern Europe through east Siberia to Kamchatka. In recent years, a further dispersion towards northern America has been observed (Bauer et al. 2005a). After a strong increase during the 1970s the European breeding population of black-headed gulls currently stands at 1.5 – 2.2 million pairs, although there has been a decline since the 1990s, particularly in countries bordering the Baltic Sea (BirdLife International 2004). The world population is estimated at 4.9 – 8.9 million individuals, with the west and central European breeding population consisting of c.3.7 – 4.8 million birds (Delany & Scott 2006).

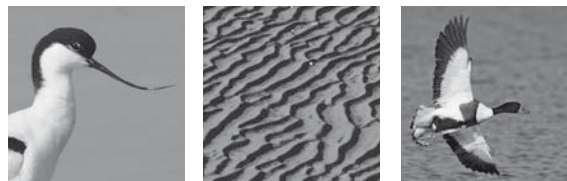
Breeding population size in the German Wadden Sea, distribution and trends

Black-headed Gulls have bred on the German North Sea coast only since 1931. Prior to that, the species bred only at inland locations. Numbers breeding in Germany in 1999 were estimated at 151,000 pairs, with just under half breeding inland (Bellebaum 2002). Many birds moved from inland breeding sites and from the Baltic Sea to the Wadden Sea coast (e.g. Hälterlein 1998; Hälterlein et al. 2000; Berndt et al. 2003). This has led to a strong and almost exponential increase in breeding numbers in the German Wadden Sea since the 1970s

(Garthe et al. 2000). However, in recent years the strong population increase in the German Wadden Sea has levelled off, off or even begun to reverse. While there were around 33,000 pairs on the Schleswig-Holstein Wadden Sea coast in 2001 (Koffijberg et al. 2006), by 2006 there were only 20,800 pairs (and only slightly higher numbers in 2005) (Hälterlein unpubl. data). The same is true for Niedersachsen: in 2001 45,000 pairs were recorded (Koffijberg et al. 2006), but only 24,600 pairs in 2006 and numbers have never exceeded 35,000 pairs since 2001 (Südbeck unpubl. data). It is possible that trends in Germany will follow negative developments in the Netherlands and Denmark that have been observed for a number of years (Heldbjerg 2001, Koffijberg et al. 2006). Furthermore, since the 1990s there have been contrasting trends between mainland sites and islands. Numbers breeding on the islands have increased steadily, but numbers at mainland sites have declined (Koffijberg et al. 2006). The most important breeding sites are on the East Friesian Islands, which hold several thousand breeding pairs. Significant numbers are found on the Halligen in Schleswig-Holstein, and also on mainland salt marshes (Koffijberg et al. 2006). In 2001, across the whole of the Wadden Sea, 77% of Black-headed Gulls bred on the islands. Birds breeding on the North Sea coast forage on tidal flats, in the pelagic offshore zone, and also in inland habitats; they perform regular switches between these habitats in relation to tidal cycle and time of day (Schwemmer & Garthe 2008). Black-headed Gulls benefit from anthropogenic activities such as fisheries in the offshore zone and agriculture on the mainland (e.g. Walter & Becker 1997; Garthe et al. 1996; Schwemmer et al. 2008). This opportunistic behaviour might have enabled the strong increase in breeding numbers in the German Wadden Sea. Breeding success may vary considerably between years and between different areas; predation by mammals may play a crucial role particularly at mainland sites (Thyen et al. 2000).

Phenology in the German Wadden Sea, distribution and trend

Peak numbers of Black-headed Gulls occur from July to September. During the winter months numbers are low, but several hundred birds are usually present even in colder winters. Individuals that overwinter in the German Wadden Sea are mainly birds from the breeding areas further east. In winter most Black-headed Gulls (c.90%) can be found inland (Dachverband Deutscher Avifaunisten, unpubl. data). Numbers build up again in April, and during the spring migration they are already at a similar level to the breeding period (Koffijberg et al. 2003; Blew et al. 2005a, b). During most of the year except



during spring, there are many more Black-headed Gulls in Niedersachsen than in Schleswig-Holstein (Blew et al. 2005b). At high tide, most birds roost in salt marshes (Koffijberg et al. 2003), but a considerable proportion of birds use the offshore area (Garthe et al. 2007) and coastal mainland sites (Schwemmer et al. 2008) especially during the spring and autumn migration periods. In contrast to other gull species, Black-headed Gulls are only found quite close to the shore (Kubetzki & Garthe 2003). The most important high tide roosts are located on the island of Trischen, and in a number of mainland salt marshes (Koffijberg et al. 2003). Roosting numbers of Black-headed Gulls in the German Wadden Sea have fluctuated considerably, but show a stable trend for recent years (Blew et al. 2005a; 2007; Fig. 34).

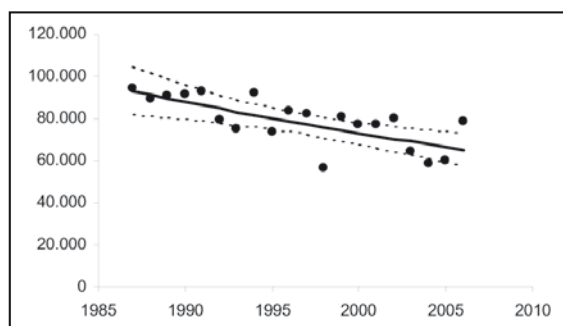


Fig. 34: Population trend of the Black-headed Gull in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

While distribution and foraging ecology are already quite well known, both in the offshore zone and at mainland sites (e.g. Schwemmer & Garthe 2008), basic information on the importance of the utilisation of tidal flats is missing. Furthermore, population dynamics of this species should be investigated more deeply, to find out the extent to which breeding birds move from the mainland to sites in the Wadden Sea. Breeding success on the islands and mainland should be compared, against the background of predation. Reasons for contrasting population trends in different habitat types (e.g. mainland and coastal sites) and in different regions (e.g. Wadden Sea coasts of the Netherlands, Denmark and Germany) should be investigated. The effect of egg and chick predation by Black-headed Gulls, and kleptoparasitism of other Wadden Sea birds such as terns, should be investigated (e.g. Gorke 1990). The role of discards from fishing vessels in sustaining breeding numbers should be studied and potential effects of reduced discard avail-

ability should be considered (also in relation to possible increased levels of kleptoparasitism and direct predation of other bird species by Black-headed Gulls).

Conservation actions

As a bird that forages at least partly in a pelagic environment, Black-headed Gulls are at risk from oil spills and chronic oil pollution, although the oiling rate is usually less than 12% (Fleet et al. 1999). The influence of predation on mainland colonies should be reduced.

Little Gull *Larus minutus*

Status: occasionally breeding, passage/wintering

Global breeding range and populations

The Little Gull is a monotypic species that breeds only occasionally on the North Sea coast. Its core breeding range extends from Finland to the Lena River in east Siberia. Since the 1960s Little Gulls have also bred in Hudson Bay and the Great Lakes in North America (Bauer et al. 2005a). The breeding population in Europe consists of 24,000 – 58,000 pairs and is currently stable following strong declines during the 1970s (BirdLife International 2004). The world population is estimated at 97,000 – 275,000 birds, with 72,000 – 174,000 individuals wintering in western Europe and north-west Africa (Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trends

The Wadden Sea is located on the western edge of the breeding range of Little Gull. Breeding attempts have been recorded occasionally since the 1960s, mainly in the polders of the mainland in Nordfriesland, such as the Hauke-Haien-Koog and Rickelbüller Koog, (for further details see Hälterlein 1998). There have been no breeding records of Little Gulls since 1996 (Boschert 2005).

Phenology in the German Wadden Sea, distribution and trends

During winter and on migration, Little Gulls mainly use the offshore zone and are rarely found at high tide roosts. In spring, the highest numbers are found in the coastal offshore regions of the German North Sea, with most birds using the 12 nm zone of Schleswig-Holstein, with smaller numbers occurring within the 12 nm zone of Niedersachsen (Garthe et al. 2007). Compared to autumn, spring migration takes place very quickly, from early April to mid May, with peak numbers of birds re-

corded during late April (Gloe 1987; Garthe et al. 1993b; Schwemmer & Garthe 2006). The most important aggregations can be found in around Helgoland and at the mouth of the Eider. Immatures migrate later than adult birds (Schwemmer & Garthe 2006) and more birds may stay over the summer; however, summer numbers are generally the lowest (Garthe et al. 2007). Autumn migration takes place between the end of September and beginning of November (Garthe 1993b). Then, the lower River Elbe is a site of major importance for this species (e.g. Zang et al. 1991; Garthe 1993a; Schwemmer & Garthe 2006). Most probably, Little Gulls are foraging on small smelt (*Osmerus eperlanus*), which would be suitable prey in terms of energy content and size (FTZ unpubl. data). In total, around 1,100 birds winter in German waters, with the highest numbers found off Niedersachsen (Garthe et al. 2007). The eastern German Bight is of high importance for Little Gulls during winter (Skov et al. 1995).

Gaps in knowledge

Currently there is little or no basic knowledge of the foraging ecology of Little Gulls in German waters. It is not known to what extent regime shifts induced by climate change might influence food availability for Little Gulls. The indirect effects of fisheries on prey availability are unknown. Overfishing of large predatory fish species might increase the abundance of small fish, which are suitable species for Little Gulls. The role of estuaries as feeding and resting habitats should be investigated. Habitat loss caused by anthropogenic activities such as the construction of offshore wind farms should be addressed.

Conservation actions

As birds that forage primarily in a pelagic environment, Little Gulls are at risk from oil spills and chronic oil pollution. Spatial planning in the offshore zone is required to minimise the impact of development such as offshore wind farms (restriction zones should be set out in sensitive areas). Colony sites must be protected against the illegal taking of eggs.

Common Gull *Larus canus*

Status: breeding, passage/wintering

Global breeding range and populations

Common Gulls are distributed throughout north Eurasia. There are three subspecies: (1) *Larus canus canus* breeding in north Europe to the White Sea; (2) *L.*

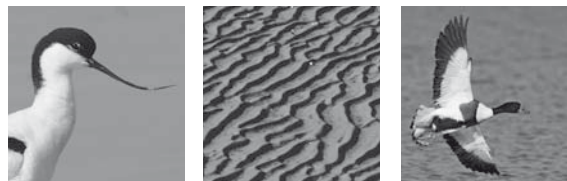
c. heinei breeding from west Russia to the Lena delta; and (3) *L. c. kamtschatschensis* breeding in north-east Siberia (Bauer et al. 2005a). The European breeding population consists of 590,000 – 1.5 million pairs and is declining in many countries of northern Europe (e.g. Norway, Sweden and Great Britain; BirdLife International 2004). The world population is estimated to be 2.5 – 3.7 million individuals; birds found in central Europe belong to the subspecies *canus* (1.2 – 2.2 million birds) and winter in coastal regions of the North Sea and the Baltic, and as far south as the Iberian Peninsula (Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trends

Most Common Gulls in the German Wadden Sea breed in dunes on the Wadden Sea islands, notably Amrum and most of the East Friesian Islands. However, smaller numbers can be found on the Halligen of Schleswig-Holstein, and a very few birds utilise habitats on the mainland coast (Koffijberg et al. 2006). In Schleswig-Holstein, c.2,900 breeding pairs were recorded in 2006, which is fewer than in preceding years (Hälterlein unpubl. data): in 2001, there were 4,227 pairs (Koffijberg et al. 2006). In Niedersachsen, there were 6,796 pairs in 2006, but only 2,464 pairs in 2001 (Koffijberg et al. 2006). This indicates a strong increase, at least for Niedersachsen, though more data are probably needed to establish a reliable trend for Schleswig-Holstein. Overall, Common Gulls experienced strong increases in breeding numbers since the 1990s, and this pattern seems to continue (Garthe et al. 2000; Mendel et al. 2008). The upward trend might also be a result of birds relocating from inland sites as a consequence of deteriorating quality of breeding sites there, due to predation and disturbance (Kubetzki 1997; Garthe et al. 2000). Numbers of roof-breeding birds have increased markedly during recent years, however, with 400–450 pairs in Schleswig-Holstein, this is still a small proportion of the population as a whole (Kubetzki & Garthe 2007). Common Gulls benefit from anthropogenic activities such as fisheries in the offshore zone (e.g. Walter & Becker 1997; Garthe et al. 1996). This opportunistic behaviour might have sustained the increase of breeding numbers at the German Wadden Sea.

Phenology in the German Wadden Sea, distribution and trends

Most non-breeding birds belong to the subspecies *canus*, but during the winter a number of birds of the subspecies *heini* can also be found at the German Wadden Sea coast. Numbers start to increase during late July and



peak in late August, and then drop steadily until November. The winter population is still considerable, with the lowest numbers being found during spring (Blew et al. 2005a, b; Garthe et al. 2007). Numbers are generally similar between Schleswig-Holstein and Niedersachsen, with slightly higher proportions in Niedersachsen during winter and on autumn migration (Koffijberg et al. 2003; Garthe et al. 2007). The midwinter population in Germany consists of around 155,000 individuals, of which two-thirds use inland areas to the north of the Mittelgebirge (mainly lowland areas or river banks; Mendel et al. 2008). The strong utilisation of inland habitats during winter is also true for coastal regions (Schwemmer et al. 2008). There is a high proportion of immatures during the winter months. The mouth of the Elbe is especially important for Common Gulls during winter (Skov et al. 1995). Common Gulls can be found much further offshore than for instance Black-headed Gulls; however, their distribution is much more coastal than Lesser Black-backed Gulls (Kubetzki & Garthe 2003). Non-breeding numbers in the Wadden Sea have been stable in recent years (Blew et al. 2005a; 2007; Fig. 35).

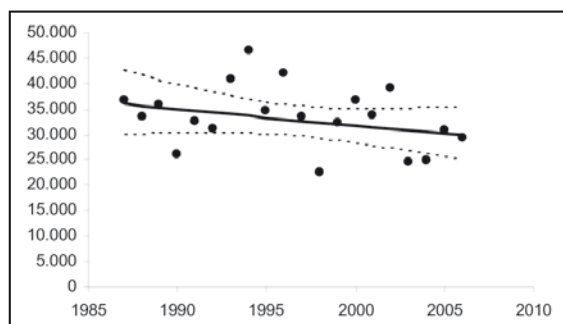


Fig. 35: Population trend of the Common Gull in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

In order to understand the population dynamics of Common Gulls in the Wadden Sea, there is a need to analyse in more detail relocations of individuals from mainland breeding habitats to sites of the German Wadden Sea coast, and the possible reasons for this. In this context the role of predation in the Wadden Sea and elsewhere should be investigated. It is necessary to gather information on the breeding success of Common Gulls in the Wadden Sea, and to compare it to inland sites. The quality of inland areas and tidal flats as foraging sites should be compared, using behavioural observations

and measures of energy intake. The role of the coastal mainland habitat and the river mouths for foraging should be studied in more detail. The effect of egg and chick predation by Common Gulls should be investigated, as well as kleptoparasitism on other Wadden Sea birds. Links between fishing discards and breeding gull numbers should be studied, with a view to assessing the potential effects of reduced discard availability (and also in relation to possible increased levels of kleptoparasitism and direct predation on other bird species by Common Gulls).

Conservation actions

There is an urgent need to halt the loss of extensively managed pastures, in order to stabilise the breeding population in the mainland, and to improve the habitat for resting and foraging. Culls such as those carried out during the 1980s should be avoided, and regulation of the breeding population should be achieved by natural mechanisms. Colony sites must be protected against the illegal taking of eggs. As a species that forages at least partly in a pelagic environment, Common Gulls are at risk from oil spills and chronic oil pollution, although the oiling rate during the winters 2001/02 was less than 7% (Fleet et al. 2003). Spatial planning in the offshore zone is required to minimise the impact of development such as offshore wind farms (restriction zones should be established in sensitive areas).

European Herring Gull *Larus argentatus*

Status: breeding, passage/wintering

Global breeding range and populations

Herring Gulls breed in the boreal and temperate zone of Europe. Two subspecies are recognised: (1) *Larus argentatus argentatus* breeding on the coasts of Denmark, Fennoscandia and the Kola Peninsula; and (2) *L. a. argenteus* breeding in Iceland and Ireland, and from Great Britain to north-western France including Germany (Bauer et al. 2005a). The European breeding population holds 760,000 – 1.4 million pairs: although there were declines in some countries around the North Sea during the 1990s, many other countries such as Russia and Scandinavia showed strong increases (BirdLife International 2004). The world population is estimated at 2.7 – 4.7 million individual birds, with the *argentatus* subspecies accounting for 1.7 – 3.6 million and *argenteus* 560,000 – 620,000 individuals (Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trend

In contrast to Black-headed and Common Gulls, the breeding range of Herring Gulls in Germany is more or less restricted to the Wadden Sea and Baltic Sea coasts, but also – to a lesser extent – the lowlands in northern Germany (Boschert 2005). Herring Gulls breed in dunes or salt marshes with tall vegetation, often intermixed with Lesser Black-backed Gulls. In the German Wadden Sea, nearly all breeding pairs are restricted to the Halligen and the islands (Koffijberg et al. 2006). Numbers there are by far the highest on the East Frisian Islands; lower numbers can be found on Trischen and on the Halligen of Schleswig-Holstein (Koffijberg et al. 2006). During the 19th century, Herring Gulls were heavily persecuted, which caused a decline in breeding numbers (Garthe et al. 2000). After persecution stopped, breeding numbers increased again during the 1980s. However, since the 1990s, numbers have declined once again (Garthe et al. 2000; Hälterlein et al. 2000). In 2006, 10,111 pairs bred in Schleswig-Holstein, and there were c.17,533 pairs in Niedersachsen. This represents strong declines compared with 2001, mainly in Niedersachsen (Schleswig-Holstein: 12,119 breeding pairs; Niedersachsen: 24,209 breeding pairs; Koffijberg et al. 2006). Potential reasons for these declines include: (1) possible competition with Lesser Black-backed Gulls (Camphuysen 1995; Garthe et al. 1999); (2) reduced availability or quality of shellfish (e.g. Scheiffarth & Frank 2005); and (3) closing of rubbish dumps near the Wadden Sea coast.

Phenology in the German Wadden Sea, distribution and trends

During the non-breeding period, both subspecies of Herring Gulls occur at the German Wadden Sea coast. The main inland aggregations in recent years have been at refuse dumps. However, since the summer of 2005, this food resource has vanished in Germany, as most refuse dumps have been closed, which has led to a strong decline in winter numbers on the German mainland (Wahl & Bellebaum 2006). The highest numbers on the Wadden Sea coast and in the adjacent offshore zone are reached during summer and autumn (Blew et al. 2005a, b; Garthe et al. 2007). This is different from inland phenological patterns, where maximum numbers occur during the winter months (Nowakowski & Buchheim 1996; Steiof 2006). There is no clear peak during spring migration (Blew et al. 2005a, b; Garthe et al. 2007). Numbers at high-tide roosts are generally higher in Niedersachsen than in Schleswig-Holstein (Blew et al. 2005b), while the opposite holds true for numbers

in the adjacent offshore zones (Garthe et al. 2007). The most important high tide roost is located on the island of Trischen (Koffijberg et al. 2003). Roosting habitats may differ between regions: most Herring Gulls in Schleswig-Holstein use sandy habitats, while in Niedersachsen many individuals rest inland or on salt marshes (Koffijberg et al. 2003). Throughout the year, the distribution of Herring Gulls is strongly associated with tidal flats (particularly during the breeding season), although high numbers can be found in the adjacent offshore zone. Numbers in the coastal mainland are low during most of the year (Kubetzki & Garthe 2003; Schwemmer et al. 2008). Considerable numbers of Herring Gulls follow shrimp trawlers in the coastal region in order to exploit discards (e.g. Camphuysen 1995; Walter & Bekker 1997). The non-breeding population in the Wadden Sea has declined significantly in recent years (Blew et al. 2007; Fig. 36).

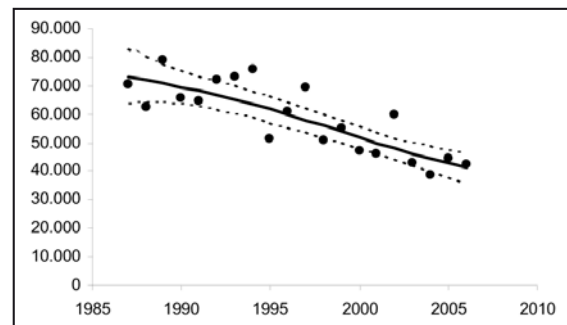
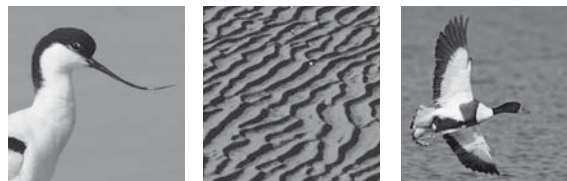


Fig. 36: Population trend of the European Herring Gull in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

As Herring Gulls feed largely on shellfish, population declines in the German Wadden Sea might be related to shellfish stocks (Scheiffarth & Frank 2005). Thus, there is a need to assess the relationships between Herring Gulls and mussel stocks in the German Wadden Sea. While a monitoring programme has been initiated for Blue Mussels, currently there is virtually no information on cockle stocks. This information is essential if one is to understand the relationships between population trends of Herring Gulls in the Wadden Sea and food availability. It is still not completely clear whether the declines in breeding numbers might also be linked to competition with Lesser Black-backed Gulls, both in foraging and breeding habitats (see e.g. Camphuysen 1995; Garthe et al. 1999). There is poor knowledge of breeding success. Regular surveys of the outer sands, which are intensive-



ly used as roosting and loafing habitats, would improve the high tide roost data. The role of discards from fishing vessels in sustaining breeding numbers should be studied and the potential effects of reduced discard availability should be considered (including in relation to possible increased levels kleptoparasitism and direct predation on other bird species by Herring Gulls).

Conservation actions

As a bird species that forages at least partly in a pelagic environment, Herring Gulls are at risk from oil spills and chronic oil pollution, although the oiling rate during the winters 2001/02 was less than 5% (Fleet et al. 2003). Spatial planning in the offshore zone is required to minimise the impact of e. g. offshore wind farms (by identifying restriction zones in sensitive areas). Herring Gulls may be prone to collision with offshore structures such as wind farms, though other seabird species are expected to be far more endangered (Garthe & Hüppop 2004). Culling measures, such as those conducted regularly before the 1980s should be avoided, and regulation of the breeding population should be achieved by natural mechanisms. Colony sites must be protected against illegal taking of eggs.

Great Black-backed Gull *Larus marinus*

Status: breeding, passage/wintering

Global breeding range and populations

The Great Black-backed Gull is a monotypic species that breeds from Iceland and the North Sea coast of Great Britain, through northern France and Fennoscandia to the Baltic States and Russia, as well as the Arctic islands and the north-eastern coast of America (Bauer et al. 2005a). Europe holds most of the world breeding population (110,000 – 180,000 pairs). During the 1990s, trends were stable or increasing in all European countries except Iceland and Ireland, where numbers declined (BirdLife International 2004). The world population is estimated at 535,000 – 745,000 birds, with the north-east Atlantic population consisting of 330,000 – 540,000 individuals (Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trends

The breeding population in Germany is very small and consists of about 30 pairs, all of which can be found on the coasts of the Wadden Sea coast or the Baltic (Mendel et al. 2008). There is no record of successful breeding from Niedersachsen before the 1990s (Zang et al. 1991).

In Schleswig-Holstein, the first breeding record was made on the Baltic coast in 1987, while one year later the first brood was recorded in the Wadden Sea, on the island of Trischen (Berndt et al. 2003). The first breeding attempt on the mainland coast of the Wadden Sea took place in 1990 at the Dithmarscher Speicherkoog (Gloe 1991). Since the early 1990s, Great Black-backed Gulls have bred regularly on the Wadden Sea coast of Schleswig-Holstein. During recent years (2000 – 2006), breeding numbers have varied between 10 and 27 pairs (Hälterlein unpubl. data). Most pairs can be found on islands such as Trischen, Sylt and some of the Halligen. In Niedersachsen, breeding pairs are now most often (though irregularly) observed on Memmert and Mellum, but numbers are still low and have ranged from 0 to 3 pairs, since the late 1990s up to 2006 (Südebeck, unpubl. data).

Phenology in the German Wadden Sea, distribution and trends

The highest numbers of Great Black-backed Gulls on the Wadden Sea coast can be found in summer and early autumn (Blew et al. 2005a, b), when some of the Scandinavian breeding birds migrate towards their wintering grounds in the southern North Sea. Phenological patterns are different in different regions of the North Sea coast: in the Schleswig-Holstein Wadden Sea, peak numbers are recorded in late summer/early autumn, while in Niedersachsen numbers peak between September and December (Garthe 2003). During the winter, numbers remain high, both on the coast of the Wadden Sea and in the adjacent offshore zone (Koffijberg et al. 2003; Blew et al. 2005a, b; Garthe et al. 2007). Birds are more or less evenly spread between Schleswig-Holstein and Niedersachsen (Blew et al. 2005b), though there are more birds in the offshore zone of Schleswig-Holstein than that of Niedersachsen (Garthe et al. 2007). Sandy habitats and salt marsh are the main roosting habitats (Koffijberg et al. 2003). Breeding season numbers of Great Black-backed Gulls (most chiefly immatures) in the offshore zone decreased strongly during 1993-2003 (Garthe & Schwemmer 2005). The at-sea distribution is very dispersed over the whole North Sea, with no aggregations in coastal areas. Discards from trawlers are very important for Great Black-backed Gulls, and the distribution of gulls at sea is significantly correlated with trawler abundance (Garthe 2003; Walter & Becker 1997). The non-breeding population using the Wadden Sea coast has declined significantly over recent years (Blew et al. 2007; Fig. 37).

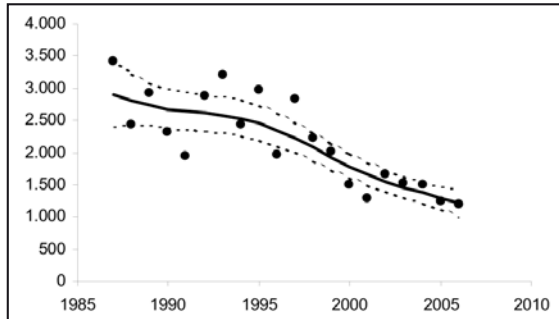


Fig. 37: Population trend of the Great black-backed Gull in the German Wadden Sea, derived from spring tide counts. Y-axis gives the number of birds. Data provided by JMMB.

Gaps in knowledge

The role of discards from fishing vessels in sustaining breeding numbers should be studied, and potential effects of reduced discard availability should be investigated (also in relation to possible increased levels of kleptoparasitism and direct predation on other bird species by Great Black-backed Gulls). The effect of changes in winter temperatures on distribution and winter numbers is not sufficiently known. Little is known about the population dynamics of birds breeding in the Wadden Sea. More regular counts of the outer sands, which are heavily used as loafing and roosting habitats, would improve the quality of high tide count data.

Conservation actions

As a bird that forages at least partly in a pelagic environment, Great Black-backed Gulls are at risk from oil spills and chronic oil pollution. Spatial planning in the offshore zone is required to minimise the impact of developments such as offshore wind farms (restriction zones should be delineated in sensitive areas). Great Black-backed Gulls may be prone to collision with offshore structures such as wind farms (Garthe & Hüppop 2004).

Lesser Black-backed Gull *Larus fuscus*

Status: breeding, passage

Global breeding range and populations

Lesser Black-backed Gulls breed from western Europe to western Siberia. Three subspecies are recognised: (1) *Larus fuscus fuscus* breeding from northern Norway to the White Sea; (2) *L. f. intermedius* breeding from south Sweden to the western Netherlands; and (3) *L. f. grael-*

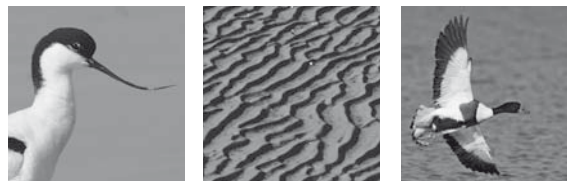
sii breeding on Iceland, Great Britain and south of The Netherlands (Bauer et al. 2005a). The European breeding population consists of 300,000 – 350,000 pairs and numbers have increased throughout western Europe, in contrast to local declines in Sweden, Finland and Russia (BirdLife International 2004). The world population is estimated to be 0.9 – 1.1 million birds; the *intermedius* subspecies, which breeds in the Wadden Sea, comprises 325,000 – 440,000 individuals (Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trend

Lesser Black-backed Gulls have bred in the German Wadden Sea since 1927, with the first record being made on the island of Memmert. However, until 1970 the breeding population was no more than 100 pairs. In the late 1980s, the population began to grow exponentially, driven by large numbers of birds that emigrated from Dutch breeding sites (for further details see Garthe et al. 2000; Hälterlein et al. 2000). At present the German Wadden Sea is one of the most important breeding areas for Lesser Black-backed Gulls within north-west Europe. Lesser Black-backed Gulls almost always breed in dune slacks, often in mixed colonies with Herring Gulls. Their main breeding sites are located on the Wadden Sea Islands, particularly on the East Frisian Islands and on Amrum, which holds the largest colony with about 11,000 breeding pairs. In 2006, about 13,400 pairs were recorded in Schleswig-Holstein and 23,451 pairs in Niedersachsen. In contrast, in 2001 there were only 7,285 pairs in Schleswig-Holstein, but 21,787 in Niedersachsen (Koffijberg et al. 2006). Nonetheless, in recent years in the German Wadden Sea it seems likely that there has been a levelling off of the population increase (as can be observed in the Dutch sites). It has been suggested that Lesser Black-backed Gulls may compete with Herring Gulls, both at breeding grounds and in foraging areas (e.g. Noordhuis & Spaans 1992; Camphuysen 1995; Garthe et al. 1999), which would explain the contrasting trends in breeding numbers for these two species. Lesser Black-backed Gulls are more competitive in the utilisation of discards from fishing vessels than most other species (Garthe & Hüppop 1998), and it is possible that this is one important reason for the strong increase of breeding numbers.

Phenology in the German Wadden Sea, distribution and trends

The Lesser Black-backed Gull is a species with a pelagic foraging ecology. Thus, most birds can be found in the offshore zone at a fair distance from the coast, even during the breeding season (e.g. Kubetzki & Garthe 2003;



Schwemmer & Garthe 2005). Lesser Black-backed Gulls are rarely found at high tide roosts, as they usually stay in their offshore foraging and resting habitat. Resting or foraging on tidal flats is very uncommon, although it is not clear how much this species uses the outer sands for resting. Lesser Black-backed Gulls start to immigrate into the German Bight during March and numbers peak during April. Autumn migration is much more extended and takes place from June to end of September. In November virtually all birds have left the German Bight and the adjacent coastal zone (Schwemmer 2003). The south-eastern German Bight is particularly important during summer and on spring migration (Skov et al. 1995), with up to 76,000 and 41,000 birds using the German waters and coastal zone, in the respective seasons (Garthe et al. 2007). Distribution of gulls during the non-breeding season is significantly correlated with the distribution of trawlers (Schwemmer & Garthe 2005). In line with the increasing trend of the breeding population, numbers at sea have also increased steadily in recent years. At the same time, distribution patterns have changed markedly, with more aggregations of gulls occurring in coastal waters, where many birds feed on natural prey, such as swimming crabs (*Liocarcinus* sp.; Schwemmer & Garthe 2005). Numbers of birds following coastal shrimp trawlers have also increased strongly in recent years – behaviour which was not observed to the same extent during the 1990s (Walter & Becker 1997; Bode 2008).

Gaps in knowledge

The extent to which outer sands are used for loafing and roosting is not currently known. Regular counts of these areas at high tide would improve knowledge of the resting behaviour of this species. The connection between discards from fishing vessels and increasing breeding numbers should be studied, and the potential effects of reduced discard availability should be investigated (also in relation to possible increased levels of kleptoparasitism and direct predation on other bird species by Lesser Black-backed Gulls). As diet analyses show an increasing proportion of terrestrial prey in recent years (FTZ, unpubl. data), the degree to which Lesser Black-backed Gulls might extend their foraging habitats to the coastal mainland and estuaries should be investigated, as should the likelihood that they might compete there with other birds (in particular other gulls such as Black-headed and Common). There is no detailed information on the population dynamics or on the breeding success of Lesser Black-backed Gulls.

Conservation actions

As a species that forages at least partly in a pelagic environment, Lesser Black-backed Gulls are at risk from oil spills and chronic oil pollution. Spatial planning in the offshore zone is required to minimise the impact of development such as offshore wind farms (restriction zones in sensitive areas). Lesser Black-backed Gulls may be prone to collision with offshore structures such as wind farms, though other seabird species are expected to be far more at risk (Garthe & Hüppop 2004). Colony sites must be protected against illegal taking of eggs.

Gull-billed Tern *Gelochelidon nilotica*

Status: breeding, passage

Global breeding range and populations

Gull-billed Terns are cosmopolitan breeders with a patchy distribution. Their main breeding range extends from the semi-deserts and steppes of central Asia and Mongolia, to southern Siberia and north India. The subspecies *Gelochelidon nilotica nilotica* (breeding in the west Palearctic and Africa) and *G. n. addenda* (breeding from east India to south-east Asia) both occur in the Palearctic. The other four subspecies are found on other continents (Bauer et al. 2005a). The European breeding population consists of 12,000 – 24,000 pairs. There have been strong declines in south-eastern Europe since the 1990s, while the population in western Europe seems to be more or less stable (BirdLife International 2004). The global population is estimated to be 153,000 – 408,000 birds, with the population of west Europe and northern Africa consisting of 14,000 – 21,000 individuals (Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trend

The north-west European breeding population showed considerable declines during the last century (Hälterlein 1998). The Wadden Sea is the only site in whole of north-west Europe where breeding Gull-billed Terns can be found. Breeding in the Wadden Sea started in the 1970s in Denmark, from where small numbers of birds spread out to Schleswig-Holstein and to a lesser extent to Niedersachsen (Koffijberg et al. 2006). Up to 1990, the few pairs on the German Wadden Sea coast bred on the islands and Halligen (Berndt et al. 2003). However, since then breeding has been exclusively confined to mainland sites, where Gull-billed Terns often breed in mixed colonies with Common and Arctic Terns, or gulls. The most important site is located in the Elbe

Estuary, in Neufelderkoog in Schleswig-Holstein (since 1995; Hälterlein 1998), although there have been several records from polders in Nordfriesland and in the Hullen and Nordkehdingen SPAs in the mouth of river Elbe in Niedersachsen. In Schleswig-Holstein, 39 breeding pairs were recorded in 2006, which is more or less in the normal range for the last years (Hälterlein, unpubl. data). In Niedersachsen, six pairs were recorded in 2006 (Südbeck, unpubl. data). Fluctuating numbers are quite usual for this species (Hälterlein et al. 2000; Koffijberg et al. 2006). However, as this species is restricted to a very small number of sites, it is highly vulnerable. Gull-billed Terns do not forage in the Wadden Sea, but at terrestrial sites, where they mainly hunt small mammals and amphibians (for more details see Zang et al. 1991).

Phenology in the German Wadden Sea, distribution and trends

There is hardly any information on the size of the non-breeding population in the German Wadden Sea, as this species occurs only in rather low numbers. Observations from the Nordkehdingen SPA revealed a migration peak during early August, towards the East Friesian Islands. No birds are found in the German Wadden Sea during winter. Spring migration seems to take place very rapidly and is not at all obvious (for more details see Zang et al. 1991). During autumn, the main roosting places are located on the coast of Nordfriesland and the Eiderstedt peninsula, though roosts at inland sites are also common (Hälterlein 1998).

Gaps in knowledge

Apart from anecdotal observations, basic information on the foraging ecology of this species and on foraging habitat utilisation is missing. Knowledge of these ecological parameters is essential to develop conservation measures for this species. The effect on the species of predation of eggs and chicks is not known. Furthermore, breeding habitat selection is not understood. In recent years, there has been a shift towards lower salt marsh areas, which are more vulnerable to flooding, and it is uncertain whether disturbance or vegetation structure have influenced this. The impact of coastal protection measures on chick survival during storm events needs to be studied.

Conservation actions

As Gull-billed Terns have only few breeding sites in the German Wadden Sea (most of which are in the lower salt marsh areas), they are highly vulnerable to disturbance, predation and flooding. Disturbance at breeding sites should be entirely avoided, as this species might be very

sensitive. This is also true for mowing and other land use activities. In recent years, breeding success has been very low, due to summer storms that killed the chicks. Large chicks might possibly have escaped the floods, but many chicks are not able to reach higher parts of the salt marsh due to the presence of brushwood groynes (K. Günther pers. comm.). A useful measure to enhance breeding success might be to provide structures that give chicks the chance to escape from summer floods. Regular monitoring of the reproductive success and reasons for chick mortality are essential to determine the further conservation needs of Gull-billed Terns. Deterioration of foraging habitats such as bogs, fens and wet pastures are thought to be the main reasons for long-term declines in Gull-billed Tern numbers throughout northern Europe. Water-logging measures and reduced intensity of agriculture, particularly on pastures, might enhance the availability of food for this species.

Sandwich Tern *Sterna sandvicensis*

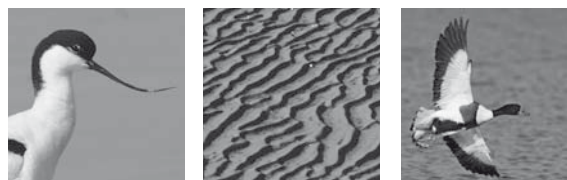
Status: breeding, passage

Global breeding range and populations

Sandwich Terns breed on the coasts of North and Central America and in north-west Europe, the Mediterranean, Black Sea and Caspian Sea. Two (or sometimes three) subspecies are recognised: (1) *Sterna sandvicensis sandvicensis* breeding in Eurasia; and (2) *S. s. acutiflvida* breeding in North America and the Caribbean (Bauer et al. 2005a). Some authors distinguish a third species, *S. s. eurygnatha* that breeds on the eastern coast of South America (Delany & Scott 2006). The European breeding population holds 82,000 – 130,000 pairs and declined moderately between 1970 and 1990; during the 1990s, this decline stopped in many European countries, but continued most severely in Great Britain and Denmark (BirdLife International 2004). The global population (excluding *S. s. eurygnatha*) is estimated to be 437,000 – 578,000 birds, with the breeding population of western Europe accounting for around 166,000 – 171,000 individuals (Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trends

The breeding colonies of the Sandwich Tern in the southern North Sea (Belgium, Wadden Sea, Denmark) form a connected population, and exchange of birds between colonies is common. Site fidelity is assumed, because traditional colonies may exist for decades, but these places may also be abandoned and new colonies



established at different sites. After severe declines in the 1960s due to pollution by organochlorines, population numbers slowly recovered. Over the last decade, overall numbers of breeding birds in the southern North Sea have been more or less stable, but with strong local fluctuations (Knief 2009).

The breeding population in Germany is restricted to coastal areas of the North Sea and the Baltic (where breeding numbers are much lower than in the former area; Hälterlein et al. 2000; Berndt et al. 2003). Numbers of Sandwich Terns breeding at the German Wadden Sea coast have fluctuated considerably over the last 100 years. During this period, the minimum number of 2,243 pairs was recorded in 1965 (when all colonies in Niedersachsen were abandoned), and a historical maximum number of 10,138 pairs was observed in 1995. After 1995, breeding numbers declined significantly: a count of 5,681 breeding pairs in 2005 was the lowest for 30 years (for more details see Garthe & Flore 2007). In 2006, there were 2,300 breeding pairs in Schleswig-Holstein, and 2,934 pairs in Niedersachsen. Currently, Schleswig-Holstein is losing its importance for the species, as the colony on the island of Trischen has been abandoned and the numbers on the Hallig of Norderoog are strongly declining. Sandwich Terns breed almost exclusively on islands (Koffijberg et al. 2006; Garthe & Flore 2007). The most important breeding site in Schleswig-Holstein is the Hallig of Norderoog. In Niedersachsen, Scharhörn, Minsener Oog and Juist were the most important sites up to 2006 (Garthe & Flore 2007). However, in recent years, Baltrum and to a lesser extent Neuwerk have also become important sites (Südbeck unpubl. data). Other colonies (such as Juist, Sylt and Süderoog) have been abandoned and partly resettled several times (see Garthe & Flore 2007 for more details). This emphasises the high variability of breeding site choice by Sandwich Terns. In contrast to the other tern species, Sandwich Terns forage further from their breeding sites, in the offshore zone (30 – 45 km), and to a lesser extent in tidal gullies in the Wadden Sea itself (Garthe & Flore 2007).

Phenology in the German Wadden Sea, distribution and trends

Sandwich Terns migrate into the German Wadden Sea from February (mainly adults) to April. At the German North Sea coast and adjacent offshore zone, a peak number of 12,500 individuals are present during spring migration (Garthe et al. 2007). In April and May, the offshore zone adjacent to the Wadden Sea coast is of the greatest importance for Sandwich Terns (Skov

et al. 1995). In the summer, a total of 21,000 birds can be found at the coast and in offshore waters (Garthe et al. 2007). Autumn migration peaks during August and September. During October, most Sandwich terns have left the Wadden Sea for their wintering ground in west Africa. Currently there is no information on trends of the non-breeding population.

Gaps in knowledge

Only a little is known about breeding habitat choice and the importance of vegetation structure. The effect of summer floods on the reproductive success should be evaluated. There is hardly any information on the population dynamics of Sandwich Terns. Reasons for resettlements of breeding colonies remain unclear, and an investigation should be carried out into the roles of anthropogenic and natural disturbance, and reduced prey availability and quality as possible factors (e.g. Stienen 2006). Although some information is available on prey selection by Sandwich Terns in the German Wadden Sea (e.g. Garthe & Kubetzki 1998), the availability and quality of suitable prey species in the foraging habitats are not known, and require investigation against the background of effects of industrial fisheries. Research at Sandwich Tern colonies must be conducted very carefully, in order to avoid disturbance. The impact of gulls of kleptoparasitism by gulls on Sandwich Terns should be investigated in more detail, in the context of population trends of gulls in the German Wadden Sea. There are potential indirect effects for Sandwich Terns resulting from reduced availability of discards for gulls, as this might increase the pressure of kleptoparasitism (e.g. Stienen 2006).

Conservation actions

The species is highly susceptible to disturbance during the breeding period, and birds might abandon breeding sites following frequent and intense disturbance events. Thus, it is important to minimise disturbance in order to facilitate reproductive success. Although the large breeding colonies used by this species are at present well protected, other potential sites should also be similarly protected, in order to provide additional suitable breeding grounds. As Sandwich Terns frequently change breeding colony sites, the conservation of potential sites would offer more options for breeding site choice. Spatial planning in the offshore zone is required to minimise the impact of developments such as offshore wind farms (restriction zones should be established in sensitive areas). Sandwich Terns are thought to be highly susceptible to collision with offshore structures such as wind farms (Garthe & Hüppop 2004). Sandwich Terns are

very susceptible to pollutants, as these substances might accumulate in their prey species and were responsible for strong declines in breeding numbers in the Netherlands during the 1960s (Koeman 1975). Thus, a further reduction of industrial and agricultural pesticides is highly desirable.

Arctic Tern *Sterna paradisaea*

Status: breeding, passage

Global breeding range and populations

The breeding range of this monotypic species is circum-polar, from the boreal zone to the high Arctic. In central Europe, the southern edge of its breeding range is the southern North Sea. The main breeding areas in Europe are located in Iceland, Scandinavia, Great Britain and the Baltic Sea. The European breeding population holds 500,000 – 900,000 pairs, and although it has decreased in several countries such as Great Britain, Norway and Greenland, overall the European breeding population is considered to be stable (BirdLife International 2004). Information on the world population is very approximate, with total numbers estimated to be more than 2 million birds, with the north Eurasian breeding population comprising more than 1 million individuals (Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trends

The highest numbers of Arctic Terns in the German Wadden Sea are in Schleswig-Holstein, which supports more than half of the entire Wadden Sea population (Koffijberg et al. 2006). The bulk of breeding birds can be found on the islands, with around 20% of birds using coastal mainland sites (Koffijberg et al. 2006). The most important colonies in Schleswig-Holstein are located on the North Friesian Islands, such as the Halligen of Norderoog and Süderoog, as well as on the island of Föhr. In Niedersachsen, most birds can be found on Minsener Oog and Juist. There is some difficulty in censusing breeding Arctic Terns, due to their similarity to Common Terns. Thus, data might not be as reliable as that for other breeding bird species. Nevertheless, in Schleswig-Holstein in 2006 there were around 2,800 breeding Arctic Terns, compared with 4,325 pairs in 2001 (Koffijberg et al. 2006). In Niedersachsen, a similar decreasing trend can be detected: in 2006, 730 breeding pairs were found (Südbeck unpubl. data), compared with 1,539 pairs in 2001 (Koffijberg et al. 2006). Although these trends might not be particularly reliable, the strong de-

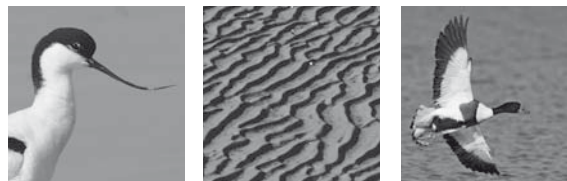
cline in breeding numbers in Niedersachsen seems to be valid, and is probably primarily due to the abandonment of several colonies such as Neuwerk, Scharhörn and Lütje Hörn, combined with strong decreases at the majority of important sites, such as Minsener Oog. These decreases seem to be a new development, as during the 1990s there was no indication of a decline, in contrast to the closely related Common Tern (Südbeck et al. 1998; Hälterlein et al. 2000). The last strong decline in breeding numbers was recorded during the 1960s and has been attributed to toxins in fish (Becker & Erdelen 1987). In contrast to Sandwich Terns, Arctic Terns largely forage within the Wadden Sea, mainly using tidal creeks and pools on the tidal flats. It has been suggested that colony location is closely related to the proximity of optimal foraging sites, where strong tidal currents result in high prey availability at the water surface (Schwemmer 2007). Boecker (1967) and Frick & Becker (1995) showed the importance of the tidal cycle in influencing foraging patterns of Arctic Terns. Like Sandwich Terns, breeding sites might be changed from one year to the next, resulting in great variability in colony location.

Phenology in the German Wadden Sea, distribution and trends

Arctic Terns are long-distance migrants with the longest migration routes of any bird species. Their wintering areas extend from the coasts of South Africa and South America to the Antarctic. During the summer, a total of 15,500 birds use the German Wadden Sea and adjacent offshore zone, while numbers are estimated to be 7,500 birds during spring migration (Garthe et al. 2007). Numbers are much lower during autumn migration (3,100 individuals; Garthe et al. 2007), and in winter this species is virtually absent from Germany (see also Zang et al. 1991 for phenology in the mainland of Niedersachsen). Currently, no information is available on trends of the non-breeding population.

Gaps in knowledge

There is hardly any information on the population dynamics of Arctic Terns in the German Wadden Sea. There is insufficient knowledge of breeding success and the role of predation. The role of summer floods on reproductive success should be evaluated. The reasons for redistribution of breeding colonies remain unclear: the role of anthropogenic and natural disturbances, and deteriorated prey availability and quality should be investigated. Although a programme has been started in a colony at the Eider Estuary (N. Markones & A. Dänhardt unpubl. data), recent information on prey choice of Arctic Terns is lacking. The availability and



quality of suitable prey species in the foraging habitats are unknown, but need to be studied against the background of effects of industrial fisheries. In this context, the role of the mainland coast and estuaries as foraging grounds should be studied in more detail, in order to determine the suitability of alternative sites close to the Wadden Sea. The influence of vegetation structure and of predation on breeding site quality should be elucidated. The impact of kleptoparasitism by gulls on Arctic Terns should be investigated in more detail, against the background of population trends of gulls in the German Wadden Sea. There are potential indirect effects on Arctic Terns if reduced availability of discards for gulls were to amplify the pressure of kleptoparasitism.

Conservation actions

Although at present most breeding colonies used by this species are well protected, other potential sites should also be similarly protected, in order to provide additional suitable breeding grounds. As Arctic Terns move breeding colony sites very frequently, the conservation of potential sites would offer more options for breeding site choice. Arctic terns are very susceptible to pollutants, as these substances accumulate in their prey species and previously caused strong declines of breeding numbers in the German Wadden Sea during the 1960s (Becker & Erdelen 1987). Thus, further reductions of industrial and agricultural pesticides are highly desirable.

Common Tern *Sterna hirundo*

Status: breeding, passage

Global breeding range and populations

The breeding range of Common Terns is extensive. In Eurasia, this species breeds from north-west Europe to east Siberia. In America it is patchily distributed from Canada to the Caribbean. In addition, it breeds in north-west Africa (Bauer et al. 2005a). Four subspecies are recognised: (1) *Sterna hirundo hirundo* breeding in the Holarctic, apart from north-east and central Asia; (2) *S. h. tibetana* breeding in and around Tibet; (3) *S. h. longipennis* breeding in north-eastern Asia; and (4) *S. h. minussensis* breeding from Mongolia to Lake Baikal (Bauer et al. 2005a). The European breeding population is 270,000 – 570,000 pairs and the population trend is stable (BirdLife International 2004). The global population is estimated to be between 1.6 and 4.6 million birds, with the western European population comprising c.170,000 – 210,000 individuals (Delany & Scott 2006).

Breeding population size in the German Wadden Sea, distribution and trends

Common Terns are very widespread over the whole of the Wadden Sea, with most birds breeding on the islands. In 2006 there were 3,168 breeding pairs breeding in Schleswig-Holstein, and 3,049 pairs in Niedersachsen. This amounts to a total of 5,705 breeding pairs for the whole German Wadden Sea in 2006. This compares with 7,981 breeding pairs recorded in 2001 (Koffijberg et al. 2006). The population of Common Terns in the Wadden Sea crashed during the 1950s and 1960s due to organochlorine pollution. However, numbers recovered during the 1980s and 1990s, and pollution has declined to a level which is no longer considered to impact the reproductive performance of Common Terns (Thyen & Becker 2000; Becker et al. 2001; Becker & Muñoz-Cifuentes 2004). A second period of declines was recorded during the 1990s (Südbeck et al. 1998; Koffijberg et al. 2006). However, breeding numbers seem to have levelled off during the last five years, although at much lower levels than at the beginning of the 1990s (Hälterlein; Südbeck, unpubl. data). In Schleswig-Holstein, the most important breeding colonies were located on the Halligen of Nordfriesland. The once very important colony on the island of Trischen was largely abandoned several years ago, and a large colony became established in the salt marshes at the mouth of the River Elbe (Südbeck et al. 1998; Hälterlein 1998). Until very recently, the largest colony in the entire Wadden Sea was Minsener Oog in Niedersachsen (2,813 pairs in 2001; Koffijberg et al. 2006), but this colony has declined dramatically over the last few years, and in 2006 only 340 pairs were recorded (Südbeck, unpubl. data). Various factors have been suggested as reasons for the overall decline in breeding numbers: (1) reduced food availability leading to poor reproductive success; (2) natural successional vegetation growth in dunes and salt marshes, leading to a loss of suitable breeding habitat, as Common Terns require open areas with sparse vegetation; (3) increased predation pressure by mammals and gulls; (4) competition for nest sites with other seabird species, primarily gulls; and (5) increased storminess in the breeding season causing nests to be washed out and total breeding failures (for further details see e.g. Becker et al. 1997; Becker 1998; Koffijberg et al., 2006; Südbeck & Hälterlein 1997; Südbeck et al. 1998; Thyen et al. 2000). Breeding success may vary considerably between different years and areas (Thyen et al. 2000). For colonies in the Jade, Becker (1998) estimated a mean breeding success of 0.8 chicks per pair during 1981-1996, although there was great variation between colonies and years. Like Arctic Terns but in contrast to Sandwich Terns, Common

Terns forage largely within the Wadden Sea and mainly use tidal creeks and pools on tidal flats (Becker et al. 1993a; Schwemmer et al. in prep.). Although there is a high dynamic in the choice of breeding sites, it has been suggested that the colony location is closely related to the proximity of optimal foraging sites, where strong tidal currents result in high prey availability at the surface of the water (Schwemmer 2007). Moreover, several authors have pointed out the strong influence of the tidal cycle on prey availability and foraging patterns of Common Terns (e.g. Boeker et al. 1967; Becker et al. 1991; Frank & Becker 1992).

Phenology in the German Wadden Sea, distribution and trends

Common Terns are long-distance migrants with coastal routes from the North Sea and the Baltic Sea to their wintering grounds in western and southern Africa. Some birds take overland routes along rivers (Bauer et al. 2005a). During the autumn migration, the south-eastern German Bight and outer Elbe estuary are of high importance (Garthe 1993a; Skov et al. 1995). Adults start the autumn migration at the end of July, while immatures stay a few more weeks. During this period a peak of 5,800 birds use the Wadden Sea and adjacent offshore area (Garthe et al. 2007). By September/October, most Common Terns have left the Wadden Sea area, and in winter virtually no birds can be found. Spring migration takes place rather quickly, from March to May, and numbers in the Wadden Sea and adjacent offshore zone are much higher (10,000 individuals; Garthe et al. 2007), compared to the autumn migration. However, the highest number of birds (19,500 individuals; Garthe et al. 2007) can be found in the Wadden Sea during the breeding season (see also Zang et al. 1991 for phenology on the mainland of Niedersachsen). Currently there is no information on trends of the non-breeding population.

Gaps in knowledge

Reasons for relocation of colonies should be investigated, e.g. by means of a ringing programme. There is no information on the availability or quality of suitable prey species in the foraging areas, and this must be studied against the background of effects of industrial fisheries. In this context, the role of the mainland coast and estuaries as foraging grounds should be studied in more detail in order to determine the suitability of alternative sites close to the Wadden Sea. The influence of vegetation structure and predation on breeding site quality should be investigated. The effect of summer floods on reproductive success should be evaluated. The impact of kleptoparasitism by gulls on Common Terns

should be investigated in more detail (e.g. Gorke 1990), in the context of population trends of gulls in the German Wadden Sea. There are potential indirect effects for Common Terns arising from reduced availability of fishing discards for gulls, as this might amplify the pressure of kleptoparasitism.

Conservation actions

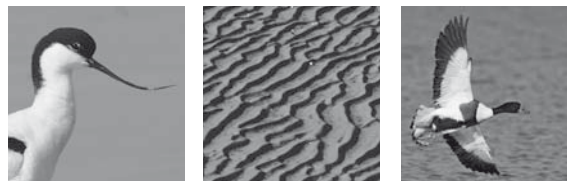
Although most breeding colonies presently used by this species are well protected, other potential sites should also be protected to a similar level, in order to provide additional suitable breeding sites. As Common Tern breeding colonies shift very frequently, the conservation of potential sites would offer a wider range of options for breeding site choice. It has been shown that the establishment of artificial breeding sites (for example in ponds or lakes close to the Wadden Sea) can enhance breeding success considerably (Becker 1996). Consideration should be given to establishing additional artificial sites, if the decline of this species in natural breeding habitats continues. Common Terns are very vulnerable to pollutants, as these substances can accumulate in their prey species and thus impair reproductive performance (e.g. Becker et al. 1993b). Thus, a further reduction of industrial and agricultural pesticides is highly desirable.

Little Tern *Sterna albifrons*

Status: breeding, passage

Global breeding range and populations

The breeding range of Little Terns is large: it extends from western Africa to Australia, New Zealand to south-east Asia, and from north-western Europe and North Africa to east India and Mongolia (Bauer et al. 2005a). Three subspecies of Little Terns are recognised: (1) *Sterna albifrons albifrons* breeding in the Palearctic and India; (2) *S. a. guineae* breeding in western Africa; and (3) *S. a. sinensis* breeding in eastern and south-east Asia, and Australasia (Bauer et al. 2005a). The European breeding population comprises 35,000 – 55,000 birds and has declined moderately in recent decades, particularly in Russia, Turkey, Italy and Great Britain (BirdLife International 2004). The global population is estimated to be 193,000 – 498,000 birds, with the west European breeding population accounting for 42,500 – 55,000 individuals (Delany & Scott 2006).



Breeding population size in the German Wadden Sea, distribution and trends

Little Terns are widely distributed throughout the German Wadden Sea. Most birds breed on the islands (Koffijberg et al. 2006). Like Kentish Plovers, Little Terns prefer primary dunes and other sandy habitats for breeding. There are similar numbers of birds on the East Friesian Islands in Niedersachsen and on the North Friesian Islands of Schleswig-Holstein. In Schleswig-Holstein, 248 breeding pairs were recorded in 2006, compared with 394 pairs in 2001 (Koffijberg et al. 2006). In Niedersachsen, 169 breeding pairs were recorded in 2006, and 298 pairs in 2001 (Koffijberg et al. 2006). After very low levels during the 1970s and 1980s, the breeding population increased markedly during the 1990s (Hälterlein et al. 2000). However, the recent census data indicate a steady decline (Hälterlein; Südbeck unpubl. data).

Phenology in the German Wadden Sea, distribution and trends

The Little Tern is a long-distance migrant, wintering in tropical Africa. Most birds start their autumn migration in the second half of July, with a peak at the end of that month and a rapid tailing off of migration at end of August. From October onwards, Little Terns are virtually absent from the Wadden Sea area until spring migration starts at the end of April, continuing into May (Bauer et al. 2005a). There is no information on trends of the non-breeding population.

Gaps in knowledge

The influence of summer floods on reproductive success of Little Terns should be evaluated. Relocation of birds between consecutive breeding seasons and within the same season should be investigated. Nothing is known about the population dynamics of Little Terns in the German Wadden Sea. Moreover, information on reproductive success is urgently needed. The location of foraging habitats in relation to breeding sites should be investigated, in order to gain more information on breeding site selection. There is no information on the availability and quality of suitable prey species in the foraging areas, and this should be investigated against the background of effects of industrial fisheries. In this context, the role of the mainland coast and estuaries as foraging grounds should be studied in more detail, in order to assess the suitability of alternative sites close to the Wadden Sea. The influence of vegetation structure and of predation on breeding site quality should be investigated.

Conservation actions

The main pressure on Little Tern breeding habitat comes

mainly from humans, as optimal tern breeding sites are frequently located on beaches that are intensively used by people for recreational activities. Visitor management is probably insufficient. Additional suitable sites should be protected from disturbance. Information campaigns should also be launched, in order to explain the problem to a broader public. As Little Terns breed close to the high tide line, additional suitable breeding sites should be established in areas that are not prone to flooding. Coastal defence measures have reduced the extent of primary dunes, the main breeding habitat of Little Terns. Coastal defence measures should be designed to allow the establishment of suitable breeding habitats. It might be beneficial to protect important breeding sites against mammalian predators by fences.

Short-eared Owl *Asio flammeus*

Status: breeding, passage/ rarely wintering

Global breeding range and populations

Eight subspecies of Short-eared Owls are recognised, but only the nominate form occurs in Europe (Bauer et al. 2005a). This subspecies is also found in Central and East Asia, as well as in North America (del Hoyo et al. 1999). The breeding range extends through the Americas, including the Galapagos and Falkland Islands, and Hawaii. The Short-eared Owl is widely distributed as a breeding bird in Eurasia, from the tundra zone to the steppes. After strong declines between 1970 and 1990, the European breeding population now holds 58,000 – 180,000 breeding pairs and has generally been stable since the 1990s, particularly in the key areas of Norway, Finland and Russia (BirdLife International 2004). The world population of Short-eared Owls varies considerably over the years, as it is highly dependent on rodent cycles (del Hoyo et al. 1999).

Breeding population size in the German Wadden Sea, distribution and trend

Short-eared Owls nest in open dunes and heathland, and forage in grassland areas or salt marshes (Koffijberg et al. 2006). As a breeding bird in the German Wadden Sea, this species is almost entirely restricted to the East Friesian Islands. Consequently, in Schleswig-Holstein normally fewer than 5 pairs have bred in recent years, with the most important sites being located on the island of Amrum and in the Dithmarscher Speicherkoog (Hälterlein, unpubl. data). In Niedersachsen, numbers are far higher and ranged from 44 and 69 pairs between 2002 and 2006, with the most important sites being

found on Spiekeroog and Langeoog (Südbeck, unpubl. data). In contrast to the population in the Netherlands, which has shown considerable declines in recent years, breeding numbers in the German Wadden Sea seem to be stable, but are highly dependent on rodent cycles (Koffijberg et al. 2006).

Phenology in the German Wadden Sea, distribution and trend

The main wintering areas of Short-eared Owls are the temperate zones and steppe areas. Consequently, several birds remain in the German Wadden Sea during winter. Winter sightings of communal roosts of up to 25 individuals are known from the Jadebusen, although numbers were higher in earlier centuries. Autumn migration may start as early as late June, but the main migration takes place during September with a peak in October. Spring migration takes place during March and April (for more details see Bauer et al. 2005a).

Gaps in knowledge

The role of vegetation structure on foraging patterns should be investigated further, as successional vegetation growth might lead to reduced foraging success. Differences in distribution and breeding densities and numbers between Niedersachsen and Schleswig-Holstein are not yet understood. Contrasting trends in breeding numbers between Niedersachsen and the Netherlands should be investigated. In this context, studies on reproductive success and foraging ecology are urgently required. There is no information on distribution or population trends during the non-breeding season. Currently it is not known if mammalian predators are likely to influence the breeding success of Short-eared Owls.

Conservation actions

It is essential to avoid disturbance at breeding sites, and additional suitable sites should be protected. Careful management of extensively used wet pastures, bogs and fens is essential to provide suitable breeding and foraging habitats. Water abstraction on dune islands must be controlled, as it lowers ground water levels and thus results in a deterioration of dune slack habitat quality. The use of rodenticides should be banned, and suitable habitats for rodents should be provided. In order to prevent direct mortality, mowing dates should be adjusted to suit the breeding cycle of Short-eared Owls. Barbed wire used in fences should be replaced by plain gauge wire, and unnecessary fences should be removed to reduce the direct loss of birds due to collision.

Rock Pipit *Anthus petrosus*

Status: occasionally breeding, passage/wintering

Global breeding range and populations

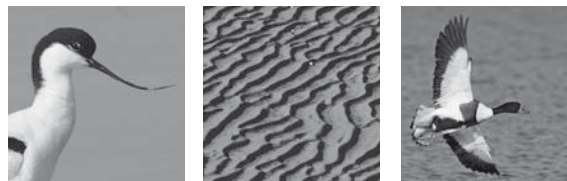
The Rock Pipit is a species found only in north west Europe, occurring mainly on the East Atlantic and North Sea coasts. Four subspecies are recognised, although the validity of the first two is debated: (1) *Anthus petrosus meinertzhageni* breeding on the Outer Hebrides; (2) *A. p. kleinschmidti* breeding on Shetland and the Faroe Islands; (3) *A. p. petrosus* breeding in the rest of the British Isles; and (4) *A. p. littoralis* breeding in Fennoscandia and Denmark to north-western Russia (Bauer et al. 2005b). The world breeding population (the same as the European population) has been stable since the 1970s, and is estimated to be 110,000 – 290,000 pairs, with the great majority breeding in Norway (c.50,000 – 200,000 pairs; BirdLife International 2004; del Hoyo et al. 2004).

Breeding population size in the German Wadden Sea, distribution and trends

There are only two German breeding records of Rock Pipit, the first one in 1999 from Helgoland in the North Sea, and the second one from Mecklenburg-Vorpommern in 2000 (Boschert 2005). Rock Pipits breed regularly in Denmark, though in low numbers, (Bauer et al. 2005a).

Phenology in the German Wadden Sea, distribution and trends

Considerable numbers of Rock Pipits use the German Wadden Sea on migration and particularly during the winter (e.g. Busche 1980). The first birds are seen during September, but the main peak in migration is recorded from October to November. Spring migration is much less pronounced, though a small peak is noticeable in March (Bauer et al. 2005a). During both migration periods and in winter, most birds utilise the upper salt marshes with tall vegetation structure. Muddy areas along ditches in the upper salt marsh areas are important foraging habitats, where Rock Pipits feed on seeds and small invertebrates (Dierschke 2002; Dierschke & Bairlein 2004). According to Aumüller (2007) wintering Rock Pipits are strongly confined to ungrazed salt marshes where they feed almost exclusively on a small copepod, *Orchestia gamarellus*. This copepod is found at its highest densities in ungrazed conditions, as it feeds on vegetation litter that is almost absent from grazed marshes. In general, the most important sites in the German Wadden Sea for Rock Pipits are large mainland salt marshes, such as those around the Jadebusen and on the Ei-



derstedt peninsula (Dierschke 2002). Dierschke (2002) roughly estimated winter numbers of Rock Pipits in Niedersachsen to be 2,200 – 3,100 individuals and 1,000 in Schleswig-Holstein. Numbers are highest during autumn migration (more than 5 individuals/10 ha) and lowest during spring migration (around 5 individuals/10 ha; Dierschke & Bairlein 2004).

Gaps in knowledge

The effect of the embankment of polders on population trends of this species has not yet been examined in detail. The influence of management measures such as different grazing intensities in salt marshes should be evaluated in more detail. Phenology, spatial distribution and wintering numbers should be studied in order to gain further information on the suitability of different sites.

Conservation actions

Careful management of salt marshes is very important for Rock Pipits. As Rock Pipits prefer high vegetation in upper salt marshes, most likely this species will benefit from a very low grazing intensity on salt marshes.

Shorelark *Eremophila alpestris*

Status: passage/wintering

Global breeding range and populations

The Shorelark has one of the largest world ranges of all songbirds. In North America in particular, it is one of the commonest birds of open habitats. There are about 42 subspecies of Shorelark worldwide, with the following being the most important found in the western Palearctic: (1) *Eremophila alpestris flava* breeding in the tundra one of Fennoscandia and Siberia; (2) *E. a. atlas* breeding in the mountains of Morocco; (3) *E. a. balcanica* breeding in the Balkan region; (4) *E. a. penicillata* breeding in the mountains of Asia Minor, Caucasus and Iran; and (5) *E. a. bicornis* breeding in Lebanon and Syria (Bauer et al. 2005b). The European breeding population is stable and holds 2.2 – 6.6 million pairs, with a particular concentration in Turkey (BirdLife International 2004). There is no reliable information on the size of the world population; however it is thought to consist of several million breeding pairs, occurring at particularly high densities in Russia and North America (del Hoyo et al. 2004).

Phenology in the German Wadden Sea, distribution and trend

The vast majority of Shorelarks wintering in the German Wadden Sea area are birds from the Scandinavian breeding population, belonging to the subspecies *E. a. flava*. Dierschke (1997; 2001) stated that c. 53% of the Scandinavian population winters in the Wadden Sea. Dramatic population declines have been recorded since the 1960s, most likely as a consequence of deteriorating foraging conditions in wintering habitats (e.g. Dierschke 1997). However, in the Netherlands this species has increased in coastal marshland areas as a result of changes in the coastal defence systems that provide suitable resting and foraging habitats during the winter months (del Hoyo et al. 2004). The influx of Shorelarks into the German Wadden Sea starts in September, with numbers remaining high throughout the winter months; in late April, birds depart from the Wadden Sea for their breeding grounds (Dierschke 1998). Winter numbers have declined strongly since the 1960s, but have recovered somewhat since the 1990s (Dierschke 1998). Dierschke (2001) estimated the winter population to be 2,000 – 3,000 individuals in Schleswig-Holstein and 2,000 – 2,500 birds in Niedersachsen. In contrast to Rock Pipits, which prefer tall upper salt marsh vegetation, Shorelarks intensively use the lower salt marsh regions and the strand-line. However, in conditions where seeds are scarce, Shorelarks may switch to upper salt marsh habitats, feeding on arthropods (for more details see Dierschke & Bairlein 2004). In general, Shorelarks mainly feed in salt marsh habitats on spring and autumn migration, whereas during the winter months they make more extensive use of the strand-line (Dierschke & Bairlein 2004). Main roost sites are located at mainland salt marshes and polders (Dierschke 1998).

Gaps in knowledge

The effects of grazing on the habitat quality for Shorelarks are still not fully understood. Dierschke & Bairlein (2004) outline important aspects on habitat selection by Shorelarks. However, there have been no analyses on the quantity or quality of food (i.e. seeds) for Shorelarks. A basic study into the question of energy supply in different habitats and during different meteorological conditions would be very useful in indicating the habitat quality of different sites and understanding the reasons for phenological patterns. The importance of *Salicornia* seeds in the diet should be clarified. Phenology and spatial distribution should be studied in order to gain further information on the relative suitability of different sites.

Conservation actions

As Shorelarks rely on lower salt marsh habitats, the presence of ungrazed lower salt marsh is essential. A higher proportion of winter fallows and stubbles on agricultural land would probably enhance the habitat quality of the Wadden Sea area for Shorelarks. It would be useful to include this species in the census scheme of high tide roost counts.

Snow Bunting *Calcarius nivalis*

Status: passage/wintering

Global breeding range and populations

The breeding range of Snow Bunting is circumpolar and encompasses even the High Arctic and the boreal zone. Four slightly different subspecies are recognised: (1) *Calcarius nivalis nivalis* breeding from North America through Greenland and Scotland as far east as the Kola Peninsula; (2) *C. n. townsendii* in the Aleutian Islands; (3) *C. n. insulae* breeding in Iceland and the Faroe Islands; and (4) *C. n. vlasowae* in northern Russia and Siberia (Bauer et al. 2005a). The European breeding population is stable and holds 680,000 – 1.7 million pairs, with key areas in Greenland and Norway (BirdLife International 2004).

Phenology in the German Wadden Sea, distribution and trend

Most birds using the German Wadden Sea during the non-breeding period come from Scandinavia, and birds originating from Siberia are rarely seen (Bauer et al. 2005b). Snow Buntings are present in the German Wadden Sea from September to April, with numbers being highest during the winter months (Dierschke 1998). The species is evenly distributed and widespread along the entire mainland coast of the German Wadden Sea, with slightly lower numbers occurring on the islands, and the most important roost site at the mouth of the River Elbe (Dierschke 1998). Like Shorelarks, Snow Buntings feed on seeds on salt marshes with shorter vegetation, as well as the strand-line, or areas extensively grazed by sheep (Dierschke 1998; Dierschke & Bairlein 2004). In general, Snow Buntings tend to feed in salt marsh habitats during spring and autumn migration, and make more frequent use of the strand-line during the winter months (Dierschke & Bairlein 2004). Numbers of Snow Buntings in the German Wadden Sea have declined dramatically since the 1960s, although a slight increase can be noticed since the 1990s (Dierschke 1998). In the 1990s, Dierschke (1998) estimated the winter po-

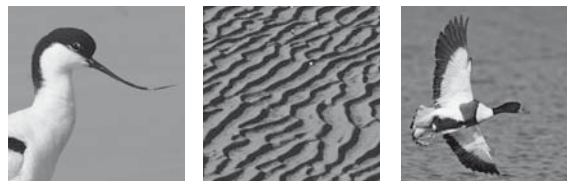
pulation of Snow Buntings on the Wadden Sea coasts of Schleswig-Holstein and Niedersachsen to be 3,000 and 5,000 individuals respectively (8,000 in total)

Gaps in knowledge

Like Shorelarks, the effects of grazing on Snow Bunting habitat quality are still not fully understood. This should be resolved by studies into the seed production (and seed quality) of plants in grazed and non-grazed conditions. Temporal patterns in the use of *Salicornia* seeds in the diet should be investigated. Phenology and spatial distribution should be studied in order to gain further information on the suitability of different sites.

Conservation actions

As Shorelarks rely on lower salt marsh habitats, the presence of ungrazed lower salt marsh is essential. It would be useful to include this species in the census scheme of high tide roost counts.



6. Conclusions

6.1 Gaps in knowledge

Over the past two decades, extensive monitoring data collected and compiled within the Trilateral Monitoring and Assessment Programme (TMAP) has been made available. Although there are some gaps (e. g. distribution and numbers of roosting birds in the remote areas of the Wadden Sea, such as the outer sands in Schleswig-Holstein), in general data coverage is good. But as TMAP is mainly intended to describe population numbers and trends, there is little information on the reasons for the observed trends, on population dynamics, or on habitat choice and quality. For most species, the driving factors are unknown, especially for species in decline. General gaps in knowledge thus refer to the following topics:

- population dynamics
- impact of human activities
- impact of climate change.

For all of these, an understanding of the feeding ecology of the species concerned is crucial.

Population dynamics

The drivers of population dynamics of most Wadden Sea bird species are only poorly understood. Detailed knowledge of reproductive rates, breeding success, survival rates and life histories is needed in order to understand the ups and downs of population. Under natural conditions, reproduction and survival are influenced by habitat quality in terms of:

- food availability
- predation
- weather conditions and floods.

Insight into these factors and their influence on the vital rates listed above is an essential prerequisite for proper management.

Impact of human activities

As the Wadden Sea is heavily influenced by man, bird population dynamics are affected by human activities. The most important factors in this context probably are

- coastal engineering
- fisheries
- management of salt marshes.

In many cases it is not known how changes in these factors might affect bird populations. In order to investigate the impacts of these factors on birds, research is needed on:

- habitat choice
- disturbance effects
- bird distribution
- habitat deterioration
- loss of birds and nests (esp. chicks and clutches).

Understanding the impact of human activities on birds and bird communities will allow better estimates of impacts at a population level, and in turn the development and support of more bird friendly practices in coastal engineering and fisheries.

Impact of climate change

Effects of climate change and sea level rise on bird populations of the Wadden Sea are still difficult to predict. The main gaps in knowledge are:

- extent of habitat loss by coastal squeeze
- changes in habitat quality of breeding and resting sites (due to more frequent and severe flooding)
- changes in the abundance and availability of food resources.

It is thus uncertain to what extent the Wadden Sea will provide in the future:

- habitat for successful breeding (weather conditions, flooding)
- suitable stop-over habitat, enabling migratory birds to reach their arctic breeding and southern wintering grounds in good condition (habitat loss, food resources, changing phenology of the birds).

Impacts of climate change on bird populations will be complex. Climate change will further influence the same factors that already affect population dynamics today (food resources, habitat quality). If the mechanics of these factors and their dependence on underlying drivers is understood, it should also be possible to assess and model the impact of climate change.

6.2 Needs for further research

Further research needs can be derived from the gaps in knowledge described above. The aim should be to provide knowledge to enable successful management of declining species in the Wadden Sea region.

6.2.1 Species selection

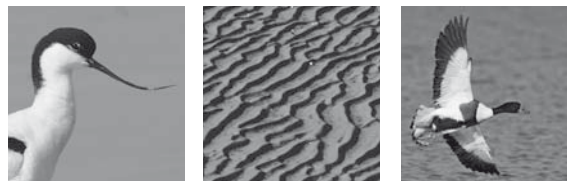
Restricted financial resources mean that future research must focus on a small number of species, and so preferably these species should be selected using the following criteria:

- a species should be one showing a negative population trend. Research is more urgent than in stable or increasing species.
- a species should be a typical Wadden Sea species, in a sense that most of its population occurs in typical Wadden Sea habitats. Population trends can possibly be linked to developments in the Wadden Sea.
- a species should be widespread within the Wadden Sea. This allows comparisons to be made between different areas.
- the final list of species should represent species groups with different feeding ecology and habitat choice.

It is to be expected that research on target species will produce results that are relevant for other species with similar characteristics. Furthermore, measures taken for those species will also benefit others. The following species are suggested:

- **Shelduck:**
Almost the entire north-west Europe population of Shelduck uses the outer Elbe estuary to moult in late summer. Numbers have been in strong decline in recent years. The reasons for this are unknown. Data on breeding success and survival rates are lacking.
- **Brent Goose:**
The Brent Goose is the archetypal Wadden Sea Goose. Having recovered from a population low in former centuries, numbers have once again declined again since the early 1990s. Poor breeding success has been observed during this time. Research is needed on breeding habitat conditions as well as on habitat quality in the Wadden Sea.

- **Oystercatcher:**
The Oystercatcher is a typical Wadden Sea bird. It is abundant and widespread as a breeder and as a non-breeding bird. It feeds on mussel beds, and so is a good indicator of the state of benthic communities and the impact of mussel fisheries. Both breeding and non-breeding populations have strongly declined in recent years.
- **Red Knot:**
The Red Knot has clear migration patterns and occurs in large numbers. Numbers are declining. Although much research has been carried out on the Red Knot in the Netherlands in recent years, the situation in the German Wadden Sea is not clear. Little is known about breeding success, food availability or distribution, as the species selects remote areas of the Wadden Sea that are difficult to monitor.
- **Kentish Plover:**
The species has endured strong declines in the past, and by 2006 only about 200 breeding pairs remained. As these pairs are concentrated at only a small number of sites, the population is highly vulnerable. The impacts of disturbance and predation are probably high, and very little is known on feeding ecology. Habitat requirements need to be understood in order to provide additional breeding habitat.
- **Great Ringed Plover:**
The species has undergone a long and steady decline since the early 1990s. It is a widespread breeding bird, but habitat choice and feeding ecology are unknown. Like Kentish Plover, it probably suffers from disturbance on beaches, and predation in salt marshes. A conservation strategy will be needed.
- **Hen Harrier:**
The German population of Hen Harrier is almost entirely restricted to the dune islands of the Wadden Sea. The population has declined strongly in recent years, as in the Netherlands. This species is an indicator for the habitat quality of dunes, but basic knowledge on feeding ecology and habitat choice are lacking.
- **Common Tern / Arctic Tern:**
These two species are long-distance migrants and highly specialised fish feeders. They have strongly declined in recent years: reasons might include temporal shifts in the availability of young fish due to climate change; increased frequency of flooding in the breeding season; and disturbance and predation.



6.2.2 Research topics

The following topics are recommended as research areas for the above mentioned species, (not all topics are relevant to all species):

- Studies of the reproductive success of birds breeding in the Wadden Sea under the threat of increased flooding and predation are urgently needed to get an indication of future population dynamics.
- Habitat quality and connectivity should be assessed throughout the flyway. Management measures for migratory birds can only be successfully implemented if the causes of the declines are understood. Therefore, further research must consider the whole flyway region. Investigations into factors influencing population dynamics (reproductive success, survival rates, predator-prey systems, weather conditions) are needed, both at and away from the Wadden Sea, e.g. in Arctic breeding sites, African wintering areas and stop-over sites. Models for predicting the reactions of bird populations at a flyway level need to be further developed.
- The effects of different types of coastal defence measures are not known at all, either for measures already applied, or for potential future measures. For example, among others the influence of: beach replenishment on benthic communities and thus food resources; different types of brushwood groyne on chick mortality (chicks can be trapped by rising water); rocky edge fixations on chick mortality (chicks might simply fall into gaps).
- Diet composition in Wadden Sea birds must be investigated in detail, in tandem with studies of benthic food resource quality, abundance and availability as underlying factors.
- The effect of dredging and other mechanical disturbance of the mudflat surface (e. g. by fisheries) on benthic communities must be assessed in terms of its impact on food resources for birds. Therefore, areas open to fishing must be compared with total reserves in terms of biomass, species composition and age structure of benthos and fish.
- The impact of disturbance (mainly by shipping, possibly also by recreational activities; but possibly also by avian predators as peregrine falcons) on the quality of roosting, foraging and breeding habitat, and

the effects of this on reproductive success should be assessed, for both resident and migratory birds.

- The impact of the spread of alien species, notably Pacific Oyster, on benthic communities, especially on natural Blue Mussel beds, has to be recorded carefully. The consequences for birds feeding on benthic species must be assessed.
- Salt marsh management can affect habitat for both breeding and roosting. However, the birds' response to different management schemes is not yet fully understood. The quality and carrying capacity of salt marsh habitat should be assessed for different bird species (as done for the Brent Geese by Bos 2002).

Research on these topics in the German Wadden Sea naturally has to take the other Wadden Sea countries into account. For example, bad conditions for Oystercatcher in the Dutch parts of the Wadden Sea could well affect numbers of both breeding and non-breeding birds further along the coast in Germany. The decline in Oystercatcher numbers was blamed on the impact of cockle fisheries and thus increased winter mortality due to shortage of food shortage. Although cockle fishing took place only in the Dutch parts of the Wadden Sea, numbers in the other parts also declined, as large numbers of Oystercatchers from all over the Wadden Sea winter in the Dutch section.

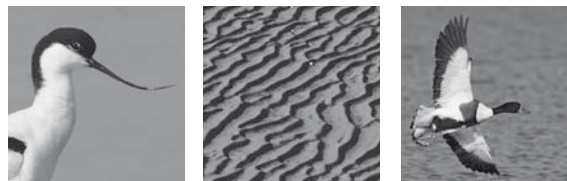
6.3 Needs for future monitoring

The present TMAP monitoring scheme has proved effective in describing population sizes and trends. It has also been able to provide high quality data on potentially influential factors, such as climate, weather conditions, eutrophication (nutrient levels), pollution (contaminants in bird eggs), habitat size (salt marsh area), conservation status and management systems (salt marsh grazing). Therefore, it is highly recommended to:

- Continue the monitoring scheme with the same parameters, and with at least the present spatial coverage, as a minimum standard to describe and assess the development of bird populations. More effort should be spent on monitoring roosting migratory birds on the remote outer sands.
- Integrate life-history variables of birds (e.g. clutch size, chick development) and breeding success into

the monitoring scheme. These are urgently needed to permit modelling and prediction of population growth rates. Furthermore, they provide data on subadult mortality. They are thus necessary for the interpretation of observed population trends. Consequently, “breeding success” should be incorporated as a new parameter into TMAP. The aim should be to carry out integrated population monitoring for at least a number of target species (e.g. Herring Gull, Black-headed Gull, Avocet, Oystercatcher, Redshank and Common Tern).

- Intensify programmes of individual marking (such as colour-ringing or satellite tracking) which will be necessary for assessing population dynamics (e.g. survival/mortality rates of adults and subadults; population growth rate; influence of environmental factors on population structure) and spatio-temporal patterns of waterbirds using the Wadden Sea (e.g. habitat use; emigration/immigration from/to the Wadden Sea in terms of stop-over rates). Ringing and re-sighting colour-ringed birds should be understood as a necessary part of the monitoring schemes. Recording of body condition during ringing could provide insight into health of the birds and habitat quality.
- Improve collaborative data collection and analysis along the whole flyway. At least for some umbrella species, monitoring of habitat quality and survival rates should be implemented.



7. The role of NABU in the conservation of the Wadden Sea

Strong NGO action is needed to keep the Wadden Sea as an outstanding site for breeding and migratory birds. Although the formal conservation status of the German Wadden Sea is agreeably high (national parks, Natura 2000), it should also be pointed out that:

- Economic interests (fisheries, oil exploitation, waterways, recreation) are strong and existing management plans (blue mussels, dredged material) reflect socio-economic rather than ecological needs.
- There are hardly any strict reserves.
- Concepts for future coastal defence strategies and measures in the face of climate change do not yet fully consider their ecological implications.
- Recent knowledge and research is nowhere near adequate to even roughly predict or assess bird population changes that might ensue from different management strategies and/or climate change.

This chapter is intended to describe areas for action by NABU in the German Wadden Sea. Different tools are needed and available to assist with this:

- Advocacy work: convince politicians to support nature conservation goals (mainly at the federal level, but also at national and international (trilateral) levels).
- Raising public awareness: enthuse the public about the Wadden Sea and make them more aware of conservation goals (mainly federal level).
- Education: inform people and involve them through teaching and guiding (mainly local level).
- Capacity building: enable NABU groups to protect the interests of the Wadden Sea (local and federal levels).
- Scientific work in order to understand the drivers for population dynamics of birds in the Wadden Sea, and to improve the management of the Wadden Sea (Michael-Otto-Institut im NABU and volunteers).

- Practical Management (mainly local level).

Close collaboration between NABU, other NGOs and research institutes will be needed.

7.1 Defend the Wadden Sea against current threats

This section covers issues of importance across the whole Wadden Sea, requiring advocacy and action by NABU and others. Current threats need to be tackled urgently, and public awareness must be raised. A campaigning approach will be necessary for the first two of the following topics.

7.1.1 Prevent (further) oil and gas extraction

In June 2009, the Wadden Sea was declared a UNESCO World Heritage Site (WHS). As exploration and extraction of resources does not comply with the UNESCO management requirements, existing production plants in Leybucht (Niedersachsen, gas) and on the Mittelplate (Schleswig-Holstein, oil) were excluded from the WHS. Further areas were excluded to allow for future oil exploration. The company involved (RWE-DEA) is likely to apply for the relevant exploration licences in the very near future. If new oil is found, new production platforms could be installed. The prospect of expansion of oil extraction within the national parks is thus a real threat.

- No licences should be issued for further exploration. Once new oil reserves have been found, extraction is probably inevitable.

Further arguments against exploration are:

- Both exploration and extraction cause huge disturbance for birds and possibly also marine mammals – over years (exploration) and decades (extraction).
- The plans affect a highly sensitive part of the Wadden Sea – the moulting site in the outer Elbe estuary for

almost the entire north-west European population of Shelduck, which is strongly declining.

- In the context of climate change, further oil and gas exploitation is no longer in the public interest.

As a medium and long term goals, the existing production facilities should also be removed from the conservation areas.

7.1.2 Restrict fisheries and shipping traffic in sensitive areas

As already described (see chapter 4.2), fisheries within the German Wadden Sea national parks are regulated only loosely and do not take account of ecological needs. The influence of fisheries on benthic communities and thus birds' food resources is high. Furthermore, there are no restrictions on shipping within the national parks (apart from some speed limits). Thus, there is significant disturbance of moulting and roosting birds as well as hauled-out seals. Therefore, NABU advocates:

- The designation of strict reserves (no shipping, no fishing) to protect the moulting sites of waterbirds.
- A general restriction on all bottom fisheries in areas that are of high value for benthic communities (e. g. *Sabellaria*).
- A ban on taking Blue Mussel as seed from the intertidal area.

7.1.3 Advocate the development of specific management plans and ask for Natura 2000 impact studies

Within the national parks, some activities require higher ecological standards, or at least comprehensive environmental assessment. Specifically, these are:

- Blue Mussel fisheries
- sand extraction
- dredging of shipping channels
- disposal of dredgings
- coastal defence measures.

In the future, these activities must not be carried out without specific management plans or permissions that reflect the ecological needs of habitats and species. Comprehensive "appropriate assessments" („FFH-Verträglichkeitsprüfungen“) must be carried out, including

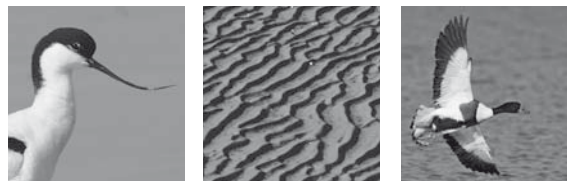
consideration of cumulative effects, to fulfil the requirements of the Habitats Directive.

In detail, NABU intends to:

- Urge the authorities to prove that the activities listed above comply with the Habitats Directive. If they do not comply, they must be stopped, or at least changed.
- Carry out proper impact studies on all coastal engineering activities. Coastal defence measures will regularly have an adverse effect on the conservation objectives of the Natura 2000 sites. Undoubtedly, these measures are often consented because of imperative reasons of overriding public interest. If adverse effects of coastal engineering on Natura sites cannot be avoided, the Habitats Directive requires compensatory measures to be implemented. These measures may not be converted into financial payment, but must compensate ecologically for the degradation of the conservation area.
- Develop management plans for Common Eider and Common Scoter. Blue Mussel fisheries and sand extraction both have strong effects on the benthos, and thus on the food resources of these two ducks. Increased mortality as a result of food shortages could have a direct effect on population sizes. There is a need to evaluate the impacts of dredging and other mechanical disturbance of the intertidal and subtidal seafloor on benthic communities as food resources for waterbirds. The management plans must adapt the levels of fisheries and sand excavation to meet the requirements of the birds.
- Evaluate levels of contamination in dredged material from harbours and shipping channels. Increased input of pollutants to the mudflats due to mobilisation of heavy metals or organic contaminants must be avoided. Dredgings should be deposited on the mainland side of the dykes. There is no obvious reason why dredgings should continuously be dumped on the salt marshes.

7.1.4 Take action against (further) introduced species

Once aquatic non-native species have become introduced to the Wadden Sea, it is impossible ever to remove them again. The only way to manage such species is to keep them out of the Wadden Sea in the first place.



NABU therefore advocates:

- Rules for shipping vessels that prevent the introduction of non-native species escaping from hulls or ballast tanks.
- A ban on the intentional release of organisms like seed mussels and other aquaculture species from outside the Wadden Sea, as these may reproduce uncontrollably. Furthermore, they may act as a vector for other organisms living on, in or amongst them.

In contrast to aquatic species, terrestrial species may under certain circumstances be controlled. Nevertheless, there is little experience in the Wadden Sea. NABU will therefore:

- Trial experimentally the removal of invasive non-native plant species (such as *Rosa rugosa*) from protected areas under NABU management, and evaluate the success of these measures.
- Try to convince the authorities to take similar measures elsewhere if there is an opportunity of halting the spread of invasive non-native plants.

7.2 Work towards the future Wadden Sea

NABU and the BirdLife-partners in the other Wadden Sea countries (*Vogelbescherming Nederland, Dansk Ornithologisk Forening*) have developed a common vision for the Wadden Sea (van Beusekom et al. 2009). This chapter should be seen as part of a vision for the future coastal landscapes. The proposed measures can partly be implemented by management, but in part also require policy decisions. NABU will try to support activities on all levels.

7.2.1 Promote the designation of no-take zones

All over the world no-take zones for fishing have proved to be an effective tool in conserving marine biodiversity, as well as enabling fish stocks to recover and thus ensure economically sustainable fisheries (see e. g. Pérez-Ruzafa et al. 2008, García-Charton et al. 2008). In the Wadden Sea, no-take zones are still very small. Therefore, action should be taken in order to:

- establish strict reserves (where no shipping and no use are allowed at all) as well as no-take zones (co-

vering areas larger than the strict reserves). No-take zones should comprise all habitat types of a tidal inlet within a comprehensive boundary.

The location of these protected areas must reflect the distribution of sensitive areas for benthos (*Sabellaria*), birds and seals. Monitoring will be required, as well as comparisons of non-fished areas with continuously fished ones, in order to measure the influence on the ecosystem and on fisheries.

To compensate fishermen for restrictions in the inner Wadden Sea area, an exclusive fishery zone for German fishermen should be declared between the 3nm and the 12nm limits. Fishing in this zone produces significantly less bycatch than in the inner Wadden Sea waters. This measure would need approval from the EU.

7.2.2 Promote sustainable fisheries

Currently, fisheries within the German Wadden Sea national parks are not sustainable, as they are not regulated according to ecological needs. The impact on benthic communities and thus on birds' food resources is high, as is the quantity of bycatch. In order to make fisheries sustainable, without totally banning them from the Wadden Sea, NABU advocates:

- Setting upper limits to the harvest of Blue Mussels, according to the needs of mussel feeding birds.
- A ban on importing seed mussels from outside the Wadden Sea.
- Promoting the introduction of fisheries techniques that are generally kind to the sea floor and benthic communities, and that minimise bycatch. The year-round application of these techniques must be enforced by law.
- Limiting the size and engine power of fishing vessels.

The designation of no-take zones is also a vital part of the process of making fisheries sustainable.

7.2.3 Enhance natural dynamics

Some measures can be taken to enhance natural dynamics and thus protect typical Wadden Sea habitats, wi-

thout abandoning the existing dykes or lowering standards of coastal defence.

Introduction of more dynamics to salt marshes:

On the mainland coast (and also on some islands), a system of brushwood groynes currently protects salt marshes from erosion and aims at stabilising the existing salt marsh. As proposed by Esselink (2000), maintenance of the groynes could be organised in a temporal and spatial rotation, with the aim of allowing salt marshes to grow and to erode again. The effect is higher dynamics in salt marsh size and age, continuously providing different morphological and successional stages and mimicking a more natural coastline.

In addition, salt marsh drainage must be reduced to the absolute minimum required.

Introduction of more dynamics to dunes:

In many places, dunes are subject to fixation and are thus characterised by ageing vegetation. Wherever necessary and possible, sand and dunes should be allowed to move inland. The ageing of dune vegetation and the spread of non-native species (such as *Rosa rugosa* or *Campylopus inflexus*) can be at least restricted by allowing new dunes to wander into older dune areas. To enable this, dune fixation by planting marram (*Ammophila arenaria*) or other dune grass species should be stopped, wherever this is possible without endangering settlements.

Introduction of more dynamics to dune slacks:

Dune slacks and dune valleys suffer seriously from a lack of dynamics. Beside a lack of wandering sand that naturally “moves” the dune valleys, wet dune slacks are particularly adversely affected by ground water extraction.

Further lowering of ground water tables in dune landscapes must be stopped. Ground water tables must be high enough to allow ponds at different times of the year. Water tables that fluctuate above and below ground level provide pioneer habitat for specialised and endangered plant species; water tables that are constantly above ground allow the establishment of fens. These habitats must be preserved as key elements of dune landscape biodiversity.

7.2.4 Improve ecological connectivity between the Wadden Sea and the mainland

Along most of the Wadden Sea coastline, dykes form a sharp and distinct border between marine and freshwater habitats. The national parks are often bounded by in-

tensively used arable land. Small rivers end at sluices and tidal outlets, making fish migration difficult. Currently, only the conservation polders (see chapter 2.3) provide habitats that are at least semi-natural, with some marine influence and less intensive land use.

A landscape-scale vision for the future coast should aim to:

- re-establish the transition zone between marine and freshwater environments, for both aquatic and terrestrial habitats.
- establish wetlands and extensively used grassland on the inland side of the dykes, as a land use gradient from intensively used arable land to the national parks. These areas should be managed mainly as roosting, feeding and breeding sites for geese and waders (with high water tables, and no vertical structures).
- enhance connectivity for fish, by making sluices and tide gates passable. Adequate spawning grounds must be provided in inland wetlands.

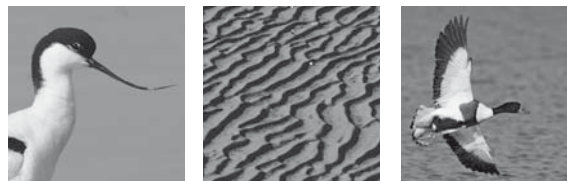
Some of these actions can surely be put into practice through nature reserve management. Measures to mitigate or compensate for impacts of projects should also be seen opportunities to achieve these goals. Support from regional and landscape planning authorities will be necessary to achieve the goal.

7.2.5 Develop management plans for endangered species and their habitats

Since establishment of the national parks, the goal of species conservation was meant to be achieved by habitat conservation. Without abandoning this aspiration, it should be pointed out that at least some species of breeding bird require special attention. If they are not subject to special conservation measures, it is most likely that they will be lost from the Wadden Sea area as breeding birds. These are specifically:

Kentish Plover, Ruff, Black-tailed Godwit, Little Tern, Sandwich Tern (only in Schleswig-Holstein), Short-eared Owl, and Hen Harrier. In the medium-term, Ringed Plover will also probably need special attention.

All of these species are either declining rapidly, and/or have very small populations that make them extremely vulnerable. Reasons for the declines are known in some cases, but not in others. NABU strongly advocates:



- Compiling knowledge on the reasons for species' declines.
- Identifying needs for specific applied research.
- Initiating and supporting applied research projects.
- Developing management plans, if applicable in collaboration with the conservation agencies.

The aim of these management plans is not to fundamentally change the focus of the national parks to species conservation measures, as opposed to allowing free rein to natural processes. Instead, the aim is to prevent local or regional extinctions of breeding birds, for which broad-scale habitat conservation is not sufficient to keep them.

7.2.6 Make tourism more sustainable

Future tourism should consider the ecological carrying capacity of the landscape and habitats used for recreation. Visitor management is still inadequate on sandy beaches and on island headlands, even within the national parks. Demand for water exceeds capacity of reservoirs on the dune islands, and causes dune slacks to dry out. By contrast, attractive facilities for nature (bird) observation are still few, and the wildlife experience could be significantly improved. NABU therefore supports

- reduction of water consumption on dune islands, e. g. by restricting golf courses and other sources of large-scale water consumption. Abstraction of water from dune areas must be restricted to a level that does not jeopardise wet dune valley habitats. If demand for water consumption can still not be sufficiently reduced, then the water supply must be provided by pipes from the mainland.
- development of a tourism strategy for the World Heritage Site, which has been called for by UNESCO. Within that strategy, future tourism must be orientated with nature conservation needs.
- stricter protection of sensitive beach bird breeding areas, without totally excluding people (more - and better - signs, fences and marked paths)
- better information for the public, in particular at critical (no access) sites, e. g. through wardens with telescopes to show the protected birds to the public from the distance.

- more - and more attractive - bird walks.

7.2.7 Make the seas litter free

Many seabirds die from ingesting litter, or after getting entangled in fishing nets. As well as litter floating at sea, litter washed ashore is also a risk for birds, e. g. when chicks entangle themselves in plastics. NABU works on this issue by:

- attending the OSPAR/HELCOM negotiations on further restrictions of litter disposal at sea
- creating possibilities for fishermen to dispose of old fishing nets in harbours, free of charge
- raising public awareness and thus keeping people from throwing litter into the water.

In some places, beached litter is counted in the framework of a monitoring scheme.

7.2.8 Minimise predation on breeding birds

Increasing predation rates, especially on mainland sites (including salt marshes) is something that must be dealt with in the near future. Mammalian predators have an increasing impact on the breeding success of coastal birds. Adequate measures should be taken as part of nature reserve management, inside and outside reserves, wherever possible. Specific measures are:

- Ensuring high water tables in winter and spring, to minimise access for mammalian predators.
- Removing bushes and trees (as potential cover for predators) in areas that are designated for breeding meadow birds and foraging geese.
- Removing artificial structures (dams, sheds, dumps), that provide habitats for predators. In salt marshes, taller structures that are not regularly flooded provide habitat for predator holes.

Locally, also controlling predators (e. g. foxes) may be an effective tool. However, the effects of predator control on predator populations are mostly short-lived. Hunting may also be associated with undesired effects.

7.2.9 Minimise loss of birds

Besides the general threats affecting the whole ecosy-

stem as described in chapter 4, there are some other factors that threaten the live of birds on the local level. Technical solutions are often available. NABU advocates their implementation:

- Replace barbed wire by plain-gauge wire in order to minimise mortality of birds, in particular raptors and owls that fly into the wire.
- Careful design of constructions such as solid coastal edge reinforcements to leave no gaps between stones. Losses of chicks that fall into these gaps in poorly designed structures could be avoided.
- Reduce unnecessary sources of light (disturbance of migrating birds).
- Avoid planning wind farms in or close to the Wadden Sea area.

7.3 Enhance co-operation and societal efforts

Many stakeholders share their interests in the Wadden Sea, and some of the threats to the Wadden Sea can only be dealt with by joint efforts of different parts of society. NABU therefore aims at forming wide alliances to protect the Wadden Sea, and actively seeks the co-operation of other (expert) groups.

7.3.1 Promote joint scientific research effort to uncover the reasons for population declines

Large gaps in knowledge and the need for specific research have been described above (see chapter 6.1, 6.2). Filling these gaps in knowledge is critically important for future habitat and species management. Therefore, research should be initiated. It is necessary to:

- promote the idea of a joint research effort to government, national and international research bodies and foundations.
- develop project outlines for both pure and applied research.
- support research projects in terms of knowledge and logistics.

- carry out research projects.

7.3.2 Help develop future coastal defence strategies

Due to climate change, sea levels will rise. Although detailed effects on the Wadden Sea are still not completely clear, erosion of islands and mudflats is likely to occur. Consequently, the Wadden Sea will be squeezed between erosion from the seaward side and a fixed border at the mainland dykes. This has implications for human safety, as well as for the ecological quality of the Wadden Sea. A coastal defence strategy is needed for the future, and it should include measures other than simply reinforcing the dykes.

The task for the NABU is to:

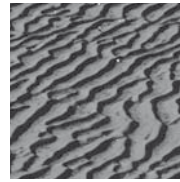
- urge federal state government to initiate a process of dialogue and discussion between coastal engineers, conservation managers and NGOs in order to agree on the fundamentals of future coastal defence strategies.
- engage in this process, and provide knowledge on ecological relationships.
- assess the effects for nature conservation.
- communicate the results to the public.

Close collaboration between nature conservation and coastal engineering interests will be needed to handle the future challenges.

7.3.3 Help develop a common vision of the future Wadden Sea region

Together with the BirdLife-partners of the other Wadden Sea countries (*Vogelbescherming Nederland, Dansk Ornithologisk Foreningen*), NABU has developed a common vision of the future Wadden Sea from the perspective of bird conservation (van Beusekom et al. 2009). To make this vision become real, NABU aims to:

- adapt the vision to the particular landscape situation in different Wadden Sea regions.
- introduce the vision to stakeholders in the German Wadden Sea region, to persuade them to share the vision and to take steps for its implementation.

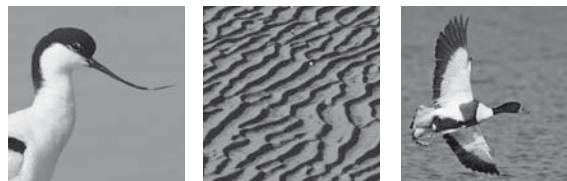


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- develop a strategy for the future landscape of the Wadden Sea that is shared between the main stakeholders and that takes the conservation of the typical natural features of the Wadden Sea fully into account.

The goal must be to prepare the future landscape of the Wadden Sea for changes in climate and sea level, and to allow the Wadden Sea region to continue to be one of global ecological importance.

8. References

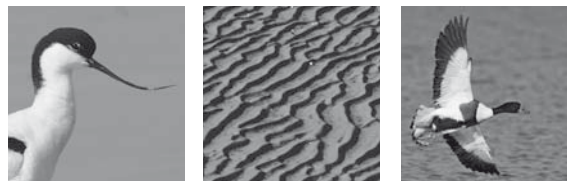
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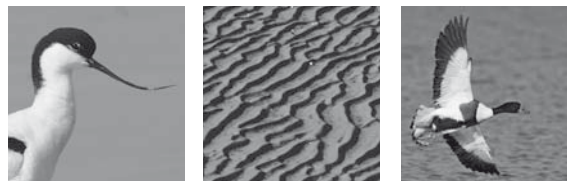
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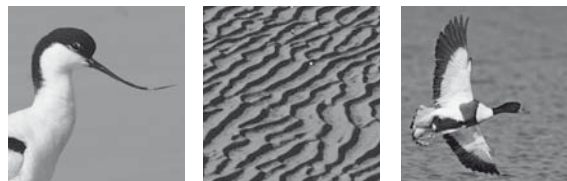
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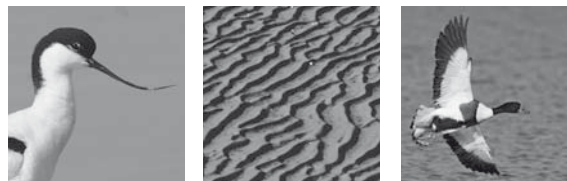
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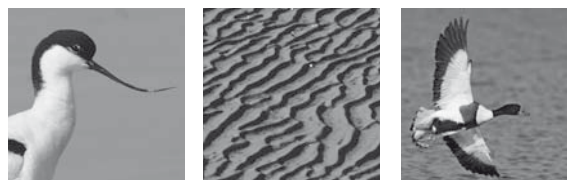
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CONTACT NABU

NABU Baden-Württemberg
Tübinger Straße 15, D-70178 Stuttgart
Tel. +49 (0)7 11.9 66 72-0
Fax +49 (0)7 11.9 66 72-33
NABU@NABU-BW.de
www.NABU-BW.de

NABU-Partner Bayern - Landesbund für Vogelschutz
(LBV) Eisvogelweg 1, D-91161 Hilpoltstein
Tel. +49 (0) 91 74.47 75-0
Fax +49 (0) 91 74.47 75-75
Info@LBV.de
www.LBV.de

NABU Berlin
Wollankstraße 4, D-13187 Berlin
Tel. +49 (0) 30.9 86 08 37-0
Fax +49 (0) 30.9 86 70 51
LvBerlin@NABU-Berlin.de
www.NABU-Berlin.de

NABU Brandenburg
Lindenstraße 34, D-14467 Potsdam
Tel. +49 (0)3 31.2 01 55-70
Fax +49 (0)3 31.2 01 55-77
Info@NABU-Brandenburg.de
www.NABU-Brandenburg.de

NABU Bremen
Contrescarpe 8, D-28203 Bremen
Tel. +49 (0)4 21.3 39 87 72
Fax +49 (0)4 21.33 65 99 12
Info@NABU-Bremen.de
www.NABU-Bremen.de

NABU Hamburg
Osterstraße 58, D-20259 Hamburg
Tel. +49 (0) 40.69 70 89-0
Fax +49 (0) 40.69 70 89-19
NABU@NABU-Hamburg.de
www.NABU-Hamburg.de

NABU Hessen
Friedenstraße 26, D-35578 Wetzlar
Tel. +49 (0) 64 41.6 79 04-0
Fax +49 (0) 64 41.6 79 04-29
Info@NABU-Hessen.de
www.NABU-Hessen.de

NABU Mecklenburg-Vorpommern
Arsenalstr. 2, D-19053 Schwerin
Tel. +49 (0)3 85.7 58 94 81
Fax +49 (0)3 85.7 58 94 98
LGS@NABU-MV.de
www.NABU-MV.de

NABU Niedersachsen
Alleestr. 36, D-30167 Hannover
Tel. +49 (0)5 11.9 11 05-0
Fax +49 (0)5 11.9 11 05-40
Info@NABU-Niedersachsen.de
www.NABU-Niedersachsen.de

NABU Nordrhein-Westfalen
Merowingerstraße 88, D-40225 Düsseldorf
Tel. +49 (0)2 11.15 92 51-0
Fax +49 (0)2 11.15 92 51-15
Info@NABU-NRW.de
www.NABU-NRW.de

NABU Rheinland-Pfalz
Frauenlobstraße 15-19, D-55118 Mainz
Tel. +49 (0) 61 31.1 40 39-0
Fax +49 (0) 61 31.1 40 39-28
Kontakt@NABU-RLP.de
www.NABU-RLP.de

NABU Saarland
Antoniusstraße 18, D-66822 Lebach
Tel. +49 (0) 68 81.93 61 9-0
Fax +49 (0) 68 81.93 61 9-11
LGS@NABU-Saar.de
www.NABU-Saar.de

NABU Sachsen
Löbauer Straße 68, D-04347 Leipzig
Tel. +49 (0)3 41.2 42 29 92
Fax +49 (0)3 41.2 33 31 33
Landesverband@NABU-Sachsen.de
www.NABU-Sachsen.de

NABU Sachsen-Anhalt
Schleinufer 18a , D-39104 Magdeburg
Tel. +49 (0)3 91.5 61 93-50
Fax +49 (0)3 91.5 61 93-49
Mail@NABU-LSA.de
www.NABU-LSA.de

NABU Schleswig-Holstein
Färberstraße 51, D-24534 Neumünster
Tel. +49 (0) 43 21.5 37 34
Fax +49 (0) 43 21.59 81
Info@NABU-SH.de
www.NABU-SH.de

NABU Thüringen
Leutra 15, D-07751 Jena
Tel. +49 (0) 36 41.60 57 04
Fax +49 (0) 36 41.21 54 11
LGS@NABU-Thueringen.de
www.NABU-Thueringen.de



The European Wadden Sea, shared by the Netherlands, Germany and Denmark, is one of the world's largest intertidal ecosystems. It is unique for the vast extent of its tidal flats and other natural coastal habitats – and it is of outstanding importance for millions of birds passing through on the East Atlantic Flyway or staying there to breed.

NABU, in alliance with its BirdLife partners VBN (The Netherlands) and DOF (Denmark) is strengthening its engagement in the Wadden Sea. This report serves as a basis for future strategies. It contains an analysis of the conservation and ecological status of the area, describes threats for birds, and identifies gaps in knowledge and topics for future action.

Major parts of the German Wadden Sea are designated conservation areas, but show substantial shortcomings. The influence of economic interests (fisheries, oil exploitation, waterways, tourism) on site management is still strong, and total reserves are almost completely lacking. Strategies for future coastal defence do not yet adequately consider ecological implications. Scientific knowledge is insufficient to explain bird population trends. It is therefore nearly impossible to predict the effects on bird populations of different management strategies and climate change.

Within the last 20 years, 19 out of 33 migratory bird species have decreased in number. For some species, the reasons for the declines are known, and indicate that insufficient management may well have contributed. NABU therefore intends to defend the Wadden Sea against current threats, to work towards a future Wadden Sea landscape and to form broad alliances with other stakeholders to ensure ecologically sustainable development of the region.