Photo: Martin Stock. Migratory birds.

Wadden Sea Quality Status Report
Migratory birds

J. Blew, K. Günther, B. Hälterlein, R. Kleefstra, K. Laursen, J. Ludwig & G. Scheiffarth

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1. Introduction

For migratory birds belonging to the East Atlantic Flyway the Wadden Sea is of great importance as a staging, wintering and moulting area. Monitoring and population development calculations in the entire Wadden Sea take place for 27 years now and for at least 39 populations of 34 migratory waterbird species (Meltofte et al., 1994; Blew et al., 2000; Laursen et al., 2010; Trend progress reports: JMMB, 2011; Blew et al., 2013, 2015, 2016). Those species breed in a large part of the Northern hemisphere, including Greenland, Canada, Fennoscandia and Russia; some species do also breed within the International Wadden Sea (see Koffijberg et al., 2016, see report "Breeding Birds"). They spend the winter in Western Europe, the Mediterranean, and Africa (wpe.wetlands.org/Iwhatfly; Engelmoer, 2008; see report "East Atlantic Flyway"). For nine of these 34 migratory species, the Wadden Sea can be considered as their most important stop-over site during migration or wintering or moulting ground, as those use the Wadden Sea with more than 50 % of their flyway population; further 14 species use the Wadden Sea with more than 10% of their flyway population (Blew et al., 2005, 2016; Laursen et al., 2010).

This Quality Status Report (QSR) report provides an update of the QSRs of 2005 and 2009 (Essink et al., 2005; Blew et al., 2005b; Laursen et al., 2009) and summarizes the results of the latest JMMB progress report with data from 1987/1988-2013/2014 (Blew et al., 2016).

2. Status and trends

2.1 TMAP monitoring scheme migratory birds

The monitoring program is organized and carried out by different institutions in the four Wadden Sea regions, including professional and volunteer counters (see Acknowledgements at end of report). The trilateral counts were initiated in 1980 and from 1987/1988 a revised and improved counting scheme was established.

The Joint Monitoring of Migratory Birds (JMMB) in the Wadden Sea, carried out in the framework of Trilateral Monitoring and Assessment Program (TMAP), consists of (a) at least two synchronous, complete counts each year, one of them in January, the other one in another month shifting from year to year and (b) frequent (bi-monthly to monthly) spring tide counts at 60 counting sites, (c) additional three counts for geese (March, May, November), and (d) aerial counts for Eider in winter and for Shelduck during wing moult (July/August) in Germany and the Netherlands. At present a total of 594 counting units from the Wadden Sea are included in the analyses. These surveys allow statistically sound estimations of numbers, phenology and trends. For a more detailed description see Blew et al. (2005, 2007) and Laursen et al. (2010).

Trends are calculated and presented for 34 waterbird species. These are species, which use the Wadden Sea during stop-over on migration or as a wintering area with large parts of their flyway population. Species which only occur in low numbers or species which cannot be counted with sufficient representativeness have been excluded from the analyses (for a more detailed explanation see Rösner et al., 1994).

Despite a large dataset with lots of count data available, coverage is not always complete and therefore missing counts are present in the dataset. To analyse the waterbird count data, UINDEX (Bell, 1995) was used to account for missing counts in the dataset, and then TrendSpotter is applied to calculate trends (Visser, 2004; Soldaat et al., 2007). The program UINDEX is estimating bird numbers for missing counts (imputing) taking into account site-, year- and month-factors (Underhill & Prys-Jones, 1994). Sites are grouped in the four different Wadden Sea regions Denmark, Schleswig-Holstein, Niedersachsen including Hamburg and the Netherlands. The counted and imputed values for each month are added to yearly averages for the respective “bird-years”, covering the period from July to June of the following year (Blew et al., 2016). TrendSpotter calculates so-called “flexible trends”, including confidence intervals (Soldaat et al., 2007). Trend estimates can be given for any period, as for example the last ten years or the whole time period, as in the current analysis.

Trend developments reflect the utilization of the Wadden Sea by the bird species considered and therefore indicate the status of the migratory bird populations of the East Atlantic Flyway population in the Wadden Sea (see report "East Atlantic Flyway"). However, they give only an indirect impression of the true (estimated) numbers of these birds in the Wadden Sea, which have short periods of maximum presence in the Wadden Sea – with spectacular numbers during migration peaks in August to October and April to May. Time periods of winter, spring, breeding, moult, and autumn are defined per species. Calculated maximum estimates are the average of the three maximum estimates during these periods, whereby estimates with more than 50 % imputed numbers (outliers) are excluded.

2.2 Trends of 34 species

Analysis of the long-term trends (27 years from 1987/1988 to 2013/2014) show that overall six species are increasing, twelve species are stable and 16 species are decreasing (Figure 1). For the short-term trends (last ten years from 2004/2005 to 2013/2014) overall six species are increasing, 14 species are stable and eleven species are decreasing; for three species no statistically significant trends could be estimated (Figure 1). For the flyway trends, 24 species trends and eleven trends for sub-populations of five species have trend estimates; of those eleven species / sub-populations are increasing, nine are stable and 15 are decreasing. No flyway trends are given for Northern Shoveler, Golden Plover, Northern Lapwing, Ruff and Great Black-backed Gull (Figure 1).

A comparison of long and short-term trends shows that of the six long-term increasing species five also increase in the short-term trend; only the Great Cormorant recently shows a moderate decrease. Changes in trend development can also be identified for Common Teal (long-term trend stable, short-term trend moderate increase). Black-headed Gull, Red Knot, Brent Goose, Whimbrel and European Golden Plover have all been decreasing in the long-term, but are stable in the short-term trends. While Curlew Sandpiper shows a long-term increase, and Kentish Plover and Ruff a long-term decrease, their fluctuating numbers do not allow for a proper trend indication in the short-term period (trends not significant).

Decreasing both in the long- and short-term trends respectively are ten species: Eurasian Wigeon, Mallard, Common Eider, Eurasian Oystercatcher, Pied Avocet, Dunlin, Common and Spotted Redshank, European Herring and Great Black-backed Gull.

A comparison between the ten year Wadden Sea trends and the Flyway trends should indicate local or flyway level reasons for population developments; e.g. if a species does worse in the Wadden Sea than on flyway level, the reason should be located in the Wadden Sea.

The comparison shows, that of the six species increasing in the Wadden Sea, Eurasian Spoonbill, Barnacle Goose and Sanderling also increase on flyway level; Northern Pintail and Ringed Plover, however, increase in the Wadden Sea but decrease in the flyway; in turn, the Pied Avocet decreases in the Wadden Sea but increases at flyway level. Five species decrease both in the Wadden Sea and in the flyway. But Great Cormorant, Mallard, Pied Avocet and Spotted Redshank decrease in the Wadden Sea but are increasing or stable at flyway level. Summing up, Northern Pintail, Ringed Plover, Whimbrel and Black-headed Gull do better in the Wadden Sea than on flyway level; in turn Brent Goose, Pied Avocet, Eurasian Curlew and Greenshank do worse in the Wadden Sea than on flyway level.

Species	27 year trend	10 year trend	Flyway trend
Great Cormorant	↑↑	↓	↑
Eurasian Spoonbill	↑↑	↑↑	↑
Barnacle Goose	↑↑	↑	↑
Brent Goose	↓	→	↓
Common Shelduck	→	→	→
Eurasian Wigeon	↓	↓	↓
Common Teal	→	↑	→
Mallard	↓	↓	→
Northern Pintail	↑	↑	↓
Northern Shoveler	→	→	—
Common Eider (22y trend)	↓	↓	↓
Eurasian Oystercatcher	↓	↓	↓
Pied Avocet	↓	↓	↑
Common Ringed Plover	↑	↑	▬
C. p. psammodroma	↑	↑	→
C. p. hiaticula	→	→	↓
Kentish Plover	↓	▬	↑
European Golden Plover	↓	→	—
Grey Plover	→	→	→
Northern Lapwing	→	→	—
Red Knot	↓	→	—
C. c. islandica	↓	→	→
C. c. canutus	→	→	↓
Sanderling	↑	↑	↑
Curlew Sandpiper	→	▬	↓
Dunlin	↓	↓	↓
Ruff	↓	▬	—
Bar-tailed Godwit	→	→	—
L. l. lapponica	→	→	↑
L. l. taymyrensis	→	→	↓
Whimbrel	→	→	↑
Eurasian Curlew	→	→	↓
Spotted Redshank	↓	↓	→
Common Redshank	↓	↓	—
T. t. totanus	↓	↓	↑
T. t. britannica	—	—	↓
T. t. robusta	↓	↓↓	↓
Common Greenshank	→	→	↑
Ruddy Turnstone	→	→	—
NE Canada and Greenland	→	→	↑
Fennoscandia and NW Russia	→	→	→
C. Black-headed Gull	↓	→	↓
Common Gull	→	→	→
European Herring Gull	↓	↓	↓
Great Black-backed Gull	↓	↓	—

↑↑ strong increase ↓↓ strong decrease ↑ moderate increase
↓ moderate decrease → stable ▬ uncertain
— do not allow trend analysis

Figure 1. Long- and short-term trends of 34 species and their respective flyway trends (QSR report "East Atlantic Flyway"). 27-year and ten-year trends as categorized trend estimates; in five species with separate populations the common trends are top, the sub-population trends are below, separated by a comma (Blew et al. 2016). Flyway trends, categorized as "increase", "decrease" and "stable" at the flyway level of Wadden Sea relevant populations calculated over the most recent ten years from the period 2000 – 2014 depending on data availability; only sub-population trends available.

2.3 Comparison of maximum estimates of the two 10 season periods

To give an impression of the magnitude of the changes in numbers over e.g. ten years, the maximum estimates of the ten-year-period 1994/1995 to 2003/2004 are compared to those of the period 2004/2005 to 2013/2014 (see Table 1).

Changes over more than 25 % occur for 15 species, seven increasing, eight decreasing.

The increases included two species with considerable numbers: The **Barnacle Goose** increased over the last two decades and uses the Wadden Sea now with a total of 511,000 individuals, some 214,000 (= 72 %) more than ten years ago. For the **Eurasian Wigeon** maximum estimates increased by some 80,000 individuals (= 25 %) to a total of almost 400,000 birds.

The increase of the Eurasian Spoonbill is remarkable, even though only some 3,300 birds are added; the increases of Whimbrel, Northern Pintail, Sanderling and Ruddy Turnstone are also >25 %, however, this may be due to some recent high counts or better coverage, which is hard to assess with these species counted with numbers less than 40,000 in the entire Wadden Sea.

The decreases include the **Common Eider** (- 118,000 = 39 %), the **Oystercatcher** (-159,000 = 28 %) and the **Herring Gull** (-109,000 = 41 %), three species depending on shellfish and showing considerable declines within the last ten years.

Further species are the Mallard (-44,200 = 27 %), the Common Gull (-69,094 = 29 %) and with lower numbers the Great Black-backed Gull (-6,010 = 35 %), Spotted Redshank (-8,994 = 40 %) and the Ruff (-3,179 = 52 %).

Finally the **Dunlin** needs to be mentioned, which has "lost" some 230.000 individuals (= 20 %) down to 940.000 in total.

Summed up for the species groups the results are clearly negative for the gulls and the waders, however positive for geese and ducks. In total, a number of 468,000 bird individuals have disappeared from the Wadden Sea comparing the two recent ten-year periods.

Table 1. Comparison of maximum estimates of an early ten-year-period with the most recent 10-year period. Colours according the relative change: >+100 % = green; +15 to +99 – light green; -15 to +15 – blue; < -15 – orange. Species sorted after their short-term trend results (see Figure 1).

Euring	Species	1994/1995-2003/2004 maximum estimates	2004/2005 - 2013/2014 maximum estimates	Late minus early estimate absolut	Late minus early estimate in %
1440	Eurasian Spoonbill	1 494	4 832	3 338	223
1670	Barnacle Goose	296 703	510 583	213 880	72
5380	Whimbrel	2 704	4 340	1 636	61
1890	Northern Pintail	25 767	40 638	14 871	58
4970	Sanderling	26 788	36 033	9 245	35
5610	Ruddy Turnstone	7 854	10 258	2 404	31
1790	Eurasian Wigeon	319 692	399 181	79 489	25
4930	Northern Lapwing	112 311	138 940	26 629	24
1730	Common Shelduck	245 486	294 635	49 149	20
4700	Great Ringed Plover	35 227	40 980	5 753	16
1840	Common Teal	43 346	49 387	6 041	14
4860	Grey Plover	130 677	141 994	11 317	9
5340	Bar-tailed Godwit	333 737	329 565	-4 172	-1
5120	Eurasian Curlew	309 861	303 555	-6 306	-2
4960	Red Knot	361 603	344 889	-16 714	-5
4560	Pied Avocet	45 744	42 974	-2 770	-6
5460	Common Redshank	82 834	76 877	-5 957	-7
4850	Eurasian Golden Plover	142 023	129 336	-12 687	-9
5480	Common Greenshank	24 934	22 243	-2 691	-11
5820	Common Black-headed Gull	503 702	448 021	-55 681	-11
1680	Dark-bellied Brent Goose	234 278	203 435	-30 843	-13
1940	Northern Shoveler	8 254	7 135	-1 119	-14
4770	Kentish Plover	807	696	-111	-14
720	Great Cormorant	24 923	21 195	-3 728	-15
5090	Curlew Sandpiper	13 747	11 673	-2 074	-15
5120	Dunlin	1 170 078	940 410	-229 668	-20
1860	Mallard	161 717	117 517	-44 200	-27
4500	Eurasian Oystercatcher	567 613	409 084	-158 529	-28
5900	Common Gull	240 151	171 057	-69 094	-29
6000	Great Black-backed Gull	17 077	11 067	-6 010	-35
2060	Common Eider	300 092	181 898	-118 194	-39
5450	Spotted Redshank	22 222	13 228	-8 994	-40
5920	Herring Gull	263 859	154 828	-109 031	-41
5170	Ruff	6 113	2 934	-3 179	-52
Sum	Cormorant and Spoonbill	26 417	26 027	-390	-1
Sum	Geese and ducks	1 635 335	1 804 409	169 074	10
Sum	Waders	3 396 877	3 000 009	-396 868	-12
Sum	Gulls	1 024 789	784 973	-239 816	-23
Sum	Total	6 083 418	5 615 418	-468 000	-8

3. Assessment

The targets for birds in the actual Wadden Sea Plan (CWSS, 2010) are:

1. Stable or increasing numbers and distribution taking into account that abundance of species is in line with prevailing physiographic, geographic and climatic conditions.
2. Breeding success and survival determined by natural processes.
3. Breeding, feeding, moulting and roosting sites supporting a natural population.
4. Undisturbed connectivity between breeding, feeding, moulting and roosting sites.
5. Fluctuations in food stocks determined by natural processes.
6. Habitat, food stocks and connectivity between habitats supporting a favourable conservation status.

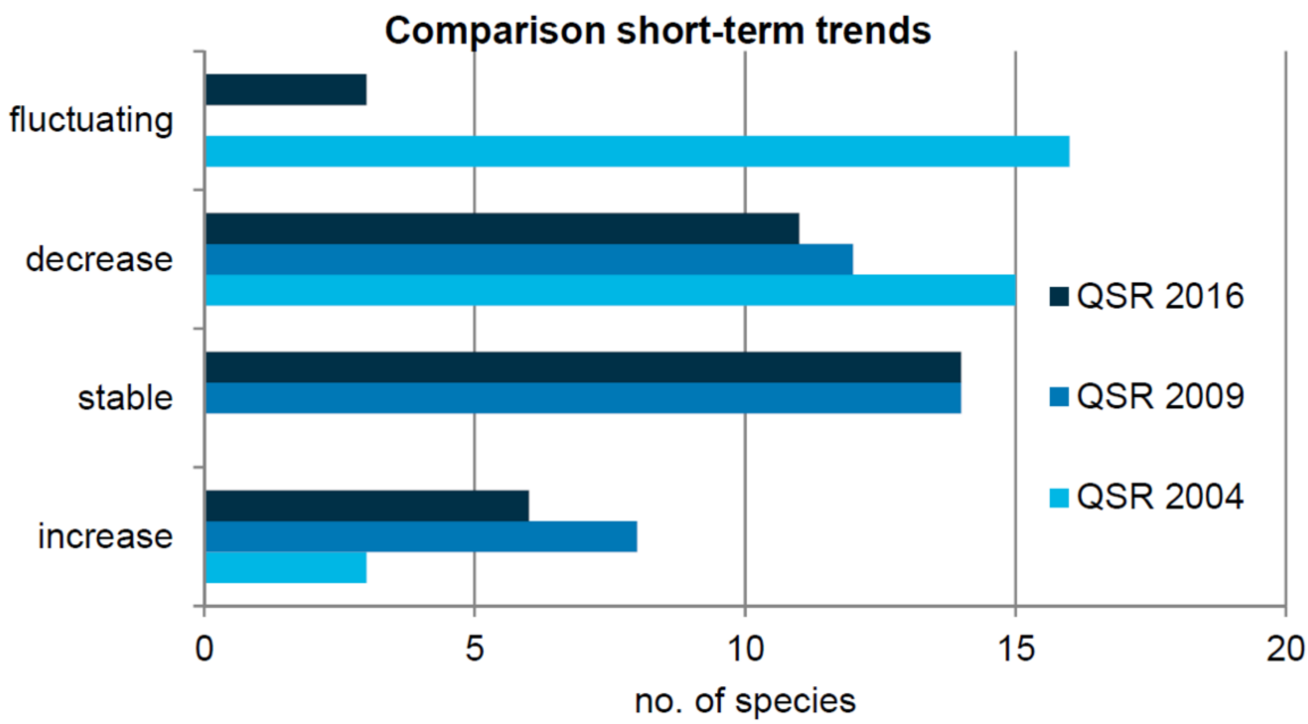
3.1 Stable or increasing numbers and distribution - Development of trends

Comparing trends as analysed for the different QSRs gives an indication of the long-term development of the status of migratory birds in the Wadden Sea.

While the monitoring programme for migratory birds started as early as 1980, sound results have been produced since the season 1987/1988. The first QSR 2004 with migratory bird trends analysed results up to 1999/2000; here the long-term trends were assessed starting from 1980 and based on expert opinion.

The comparison of the trends as published in the three QSRs from 2004, 2009 and 2016 shows:

- in the long-term trends the number of decreasing species went from 5 over 13 to now 16 species, while in the short-term trend the number of species with decreasing trends went from 15 in 2004, to 12 in 2009 and to 11 in 2016;
- in turn, the number of species with an increasing long- and short-term trend became less in comparison to 2009.



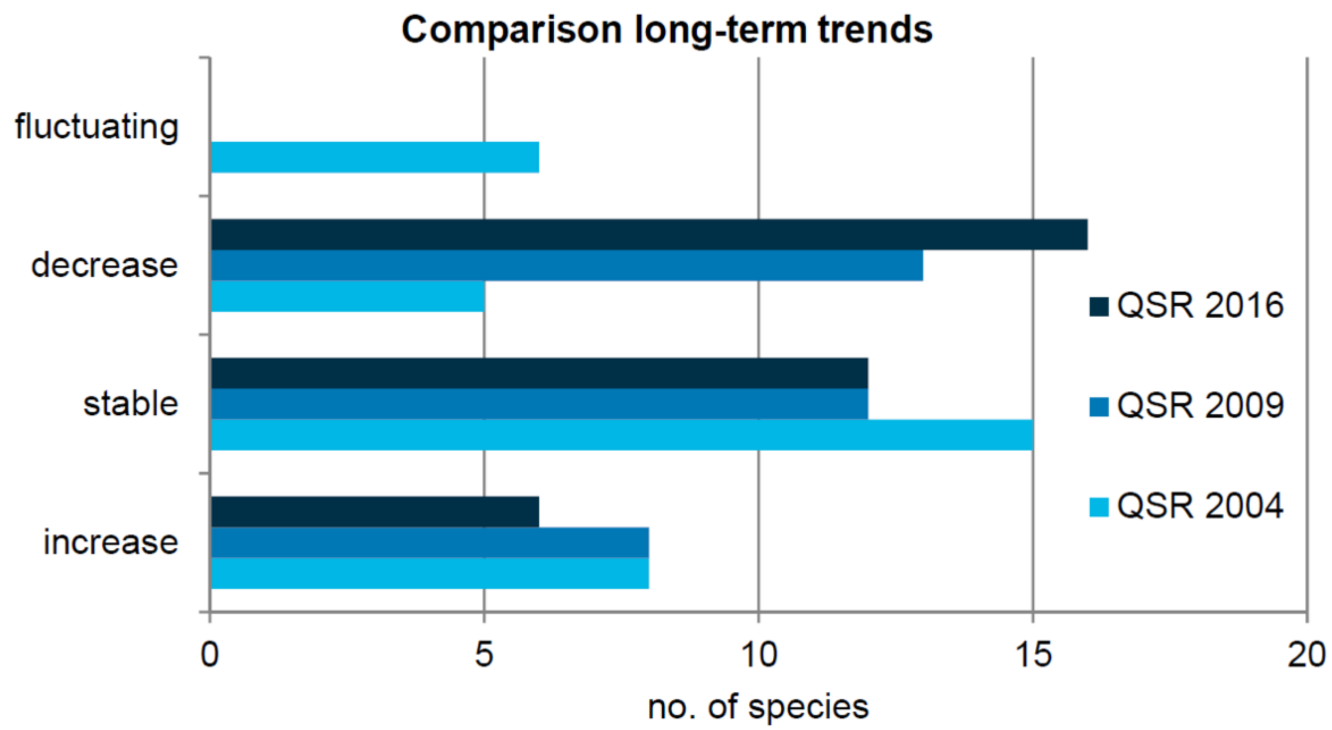


Figure 2. Summary of long- and short-term trends in migratory birds in the Wadden Sea, assessed during QSR 2004 (Essink at el., 2004; long-term trend estimates based on expert opinion), QSR 2009 (Laursen et al., in Marencic & de Vlas, 2009) and this QSR. Non-significant trends have been categorized as "fluctuating".

Ever since systematic trilateral monitoring started, four species have been increasing throughout the QSR assessments, namely Cormorant, Spoonbill, Barnacle Goose and Common Ringed Plover. On the other hand, ten species have been decreasing in those assessments, namely Mallard, Eider, Oystercatcher, Avocet, Golden Plover, Ruff and Spotted Redshank as well as Black-headed, Herring and Great Black-backed Gull.

Both balances are considerably skewed to the decreasing species.

This target is rather complex and requires an in-depth analyses of the numbers, developments and distribution of species. Current descriptions of numbers and trends do not suffice to comprehensively evaluate this target.

However, with more trends being negative than positive (Chapter 2.2), with a loss of some 500.000 birds from the early to the late ten-year period (Chapter 2.3) and with a high number of decreasing species throughout the recent QSR assessments (this chapter), it must be stated that this target is not met.

3.2 Feeding, roosting and moulting sites supporting a natural population; undisturbed connectivity between feeding, roosting and moulting sites

This target has been evaluated separately for feeding, roosting and moulting areas, respectively, regarding quality, protection status and potential disturbance levels.

3.2.1 Feeding sites

The issue of feeding sites is closely related to the evaluation of the target "*Fluctuations in food stocks determined by natural processes*." and is presented in Chapter 3.3.

3.2.2 Roosting sites

A review of bird distribution, protection regimes and potential sources of anthropogenic disturbance at high tide roosts has been undertaken by Koffijberg et al. (2003), including species accounts. Here it is stated: "*As the guiding principle for the Wadden Sea policy is to 'achieve, as far as possible, a natural and sustainable ecosystem in which natural processes proceed in an undisturbed way' (Ministerial Declaration Esbjerg, 1991), it becomes clear that the non-natural causes for disturbance effects must be reduced as much as possible.*" Assessments of these topics in the recent QSR (Essink at el., 2004; Laursen et al., in Marencic & de Vlas, 2009) have basically revisited Koffijberg et al. (2003), in which the conclusions have been:

- recreation has an impact on many high tide roosting sites and may expand, as more people visit the Wadden Sea and more people expand their stay into spring and autumn;
- hunting of waterbirds has been phased out (e.g. Eurasian Curlew in Denmark, Laursen et al., 2005); however, hunting of birds and small mammals still occurs (saltmarshes, inland roosting sites);
- the effects of civil and military air traffic (e.g. Vliehors at Vlieland, NL) must be assessed further;
- the construction of wind turbines close to the coast in some areas (disturbance, collision risk) should be assessed closely;
- further protection of more sites should be assessed to further create and safeguard undisturbed roosting sites.

Consequently, on one hand disturbance (anthropogenic sources) and on the other hand the (legal) protection of roosting sites are the main features indicating the quality of roosting sites.

As compared to the recent QSR in 2009, the issue of windfarms close to the coast have changed in that a high number of additional wind turbines have been built in recent years (see report "Energy") and should be assessed further. Many collision victims have been reported for example in a Dutch wind farm near Eemshaven (Brenninkmeijer & Klop, 2017).

Regarding the other issues mentioned above, it is assumed that changes over the recent 6-7 years are not as such as they would change the QSR 2009 assessment. However, a new inventory with a detailed mapping of roost sites should be initiated.

Two additional issues emerged in recent years:

1. potential (natural) disturbance from Peregrine Falcon and White-tailed Eagle
2. insufficient counting coverage of remote roosting sites.

The issue of natural flight distances in connection to e.g. hunting is also discussed.

1. Potential (natural) disturbance from Peregrine Falcon

An aspect which contributes to the "quality" of roosting sites – from the perspective of the roosting birds – can be the presence of predators, here the Peregrine Falcon (*Falco peregrinus*) (Ydenberg et al., 2004, 2009), of which increasing numbers occur in the Wadden Sea (van den Hout, 2009), or e.g. additional raptor species (Lanner Falcon *Falco biarmicus,* Barbary Falcon *Falco pelegrinoides)* which may affect wader roosting places in Africa (van den Hout et al., 2008). In these cases it has been shown that the presence of raptors does influence roosting site choice; smaller flocks and young birds might be exposed to a higher risk, as they have to choose more dangerous roosting sites. For the Red Knot this issue has been further analysed with regard to the Dutch Wadden Sea (van den Hout et al., 2016 or in prep).

This natural disturbance may not directly be in conflict with the target, which includes the term "*roosting sites supporting a natural population*" and clearly the presence of Peregrine falcon is – if not triggered by artificial structures (see below) – a natural phenomenon. However, as number and availability of roosting sites are limited, the increase of birds of prey like the Peregrine Falcon in the Wadden Sea may overall emphasizes the need and maintenance for a higher number of roosting sites, such that roosting birds can either evade the predation pressure or have the choice of further roosting sites such as sandbanks with an unobstructed view. Furthermore, the influence of artificial structures on some outer sands (e.g. navigational signals or emergency towers) which provide nesting opportunities for Peregrine Falcons, should be critically reviewed.

2. Insufficient counting coverage of remote roosting sites

The existence and importance of large remote roosting sites has been acknowledged in both recent QSR; however, as aerial counts have not been carried out on a regular base in most parts of the Wadden Sea, counting data from those large sites do rarely exist.

Some examples may illustrate this:

Already in 2008, an analysis of aerial counts in the Niedersachsen Wadden Sea pointed at the importance both of counting those remote islands / sand banks and also at the important roosting site quality of these sites (Scheiffarth & Becker, 2008).

In 2012 in the Schleswig-Holstein region of the Wadden Sea, two aerial counts of roosting birds at some remote sandy islands and sandbanks had been carried out (Kempf et al., 2015). The results were, that e.g. in May 2012 some 110,000 arctic waders are counted which could not be registered by the usual ground counts; in September 2012 this regards some 250,000 birds. The count of Sanderling in May 2012, for example, doubled the counted numbers of this species in the Schleswig-Holstein Wadden Sea (Kempf et al., 2015).

Results in the same order of magnitude came out from an aerial counting flight in mid May 2016 using video cameras (Weiß et al., 2016a) also covering the outer sands of Schleswig-Holstein. Here, for example, a number of some 150,000 counted Red Knots on one sand would considerably raise the most recent maximum estimate of 190,000 Red Knots in that time period in the Schleswig-Holstein Wadden Sea. In Niedersachsen, outer sands are also covered by aerial counts in 2014 and 2016 (Frank, 2016).

These results are valuable additions to the current knowledge on bird numbers in the Wadden Sea; however, as non-systematic counts they are not incorporated into the trend calculations. The study has documented that for some species the actual estimated maximum numbers are lower than the real numbers and the lack of coverage of these areas also influences the credibility of the trend estimates for some of the species.

The former target "*natural flight distances*" has now been taken care within the sub-targets "*supporting a natural population*" and "*connectivity*". Still, little information is available about flight distances in general. Recent assessments in Denmark compiled additional flight distance data of water birds in a restored wetland, but do not relate these to the issue of natural flight distances (Bregnballe et al., 2009).

The issue of hunting is closely linked to natural flight distances. Several studies have demonstrated that hunting is likely to increase flight distances e.g. for goose species and Eurasian Curlew (Wille, 2000; Madsen, 1985, 1988; Laursen et al., 2005). A comparison of the Dutch and Danish Wadden Sea demonstrated that in the Danish Wadden Sea flight distances are 1.4-2 times higher for seven species of waders and gulls. This could imply that birds may have habituated to the far higher number of people walking along the beaches and on the intertidal flats in the Dutch Wadden Sea, but also (and more likely) the far greater hunting activity in the Danish Wadden Sea at the time of the study may have led to a higher flight distance in this area. Since the seven species included both hunted and non-hunted species, the results also indicate that hunting activity influences flight distance for both groups of birds.

Another example is the reduced flight distance of geese as a consequence of both hunting ban and a wise tourism management in specific areas (Mock et al., 1998; Stock & Hofeditz, 2002). This target / issue may come into focus very soon, as activities on international level are underway, to e.g. start hunting (sustainable use) of some goose populations which have shown increases in the recent years, as the AEWA resolution 6.4 – Conservation and sustainable use of migratory waterbirds (19 April 2016) states: "*Further noting the conclusions of the international conference on goose management in Europe that was hosted by the Danish Nature Agency and Aarhus University on 27-29 October 2015 (document AEWA/MOP Inf. 6.14) and recognising the need for a coordinated management approach to the Barnacle Goose (Branta leucopsis) as well* *as other goose species in Europe, particularly those with overabundant populations.*"

While hunting of the waterbird species in most areas does not occur, hunting of small mammals (Brown Hare, Rabbit etc.) still takes place.

The evaluation of this target yields following points:

- the quality of high tide roosting sites cannot be sufficiently assessed, as the most recent evaluation goes back to 2003 (Koffijberg et al., 2003) and some issues like tourism, infrastructure (e.g. wind parks) and others have changed;
- the proposal of "sustainable use" = hunting of species with high population numbers has the potential of affecting the roosting site quality;
- missing data as e.g. (aerial) counts of remote islands / sand banks lower the quality of the trend assessments.

The evaluation cannot assess the target issues of natural populations and undisturbed connectivity.

3.2.3 Moulting sites

Several waterbird species such as swans, geese and ducks moult their flight feathers simultaneously during a period of several weeks between May and September.

In the Wadden Sea and adjacent areas in the North Sea Common Shelduck, Common Eider and Common Scoter gather for their wing moult in numbers of international importance. During this period they are not able to fly, and the birds are extremely vulnerable to predators and human disturbance and therefore congregate in remote places. Thus, the Wadden Sea countries have a great responsibility for the protection of these species. However, the species moulting behaviours and phenologies differ, thus the management requires a species specific approach.

The most important moulting sites for Shelduck are still situated within the southern Schleswig-Holstein Wadden Sea in the outer Elbe estuary (Kempf & Eskildsen, 2000; Kempf, 2007). Up to 200,000 individuals concentrate at this site during late July and August, but since 2003 these moulting concentrations have shown decreases (e.g. Blew et al., 2013). However, recently, additional moulting sites have been identified. On behalf of the JMMB group, Kempf & Kleefstra (2013) compiled an update of the existing data. During the recent 10 years, small but increasing numbers of Shelducks have been registered at several sites in the Dutch Wadden Sea (Leopold, 2003; Kraan et al., 2006) which lead to numbers as large as 77,000 in 2009 (van Roomen et al., 2002; Kleefstra et al., 2011). Consequently, for the years 2010 to 2012 an extra effort has been made to count and assess numbers of moulting Shelducks in the Dutch Wadden Sea (Kempf & Kleefstra, 2013). Between 52,000 and 67,000 Shelducks have been counted in the Dutch Wadden Sea during the moulting period in August 2010 to 2012; in addition, some 160,000 to 196,000 birds counted in the Schleswig-Holstein Wadden Sea during those periods.

Regarding moulting Shelducks in the Danish Wadden Sea, no specific data are available. Birds counted during aerial counts in summer are registered as moulting and have increased from 3,500 in the 1990s to 13,000 after the year 2000 (Laursen & Frikke, 2013).

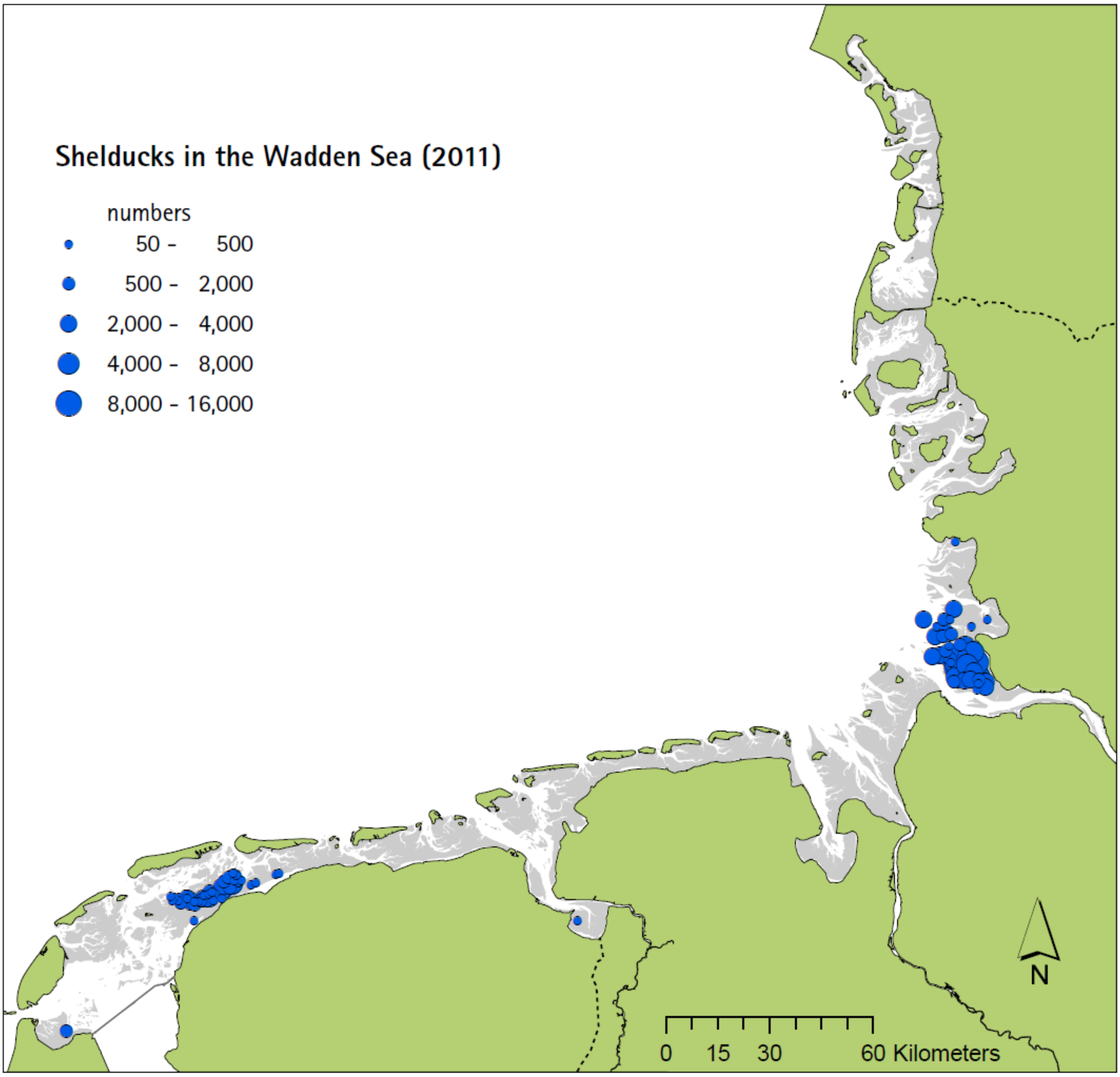


Figure 3. Distribution of moulting Shelduck in the Wadden Sea in 2011 (Kempf & Kleefstra, 2013).

Common Eiders moult from July until the end of August and early September. The birds prefer areas with low disturbance levels, rich in shellfish stocks and roosting sites on sand banks. The moulting populations in the German and Danish Wadden Sea add up to 170,000-230,000 individuals during the last two decades (Laursen et al., 1997a; Mendel et al., 2008). However, these numbers of presumably moulting birds had decreased from 1989 and onwards (Desholm et al., 2002), with a steep decline since 1994 in the major moulting sites, the North Frisian Wadden Sea (Scheiffarth & Frank, 2005). The East-Frisian Wadden Sea between Juist and Wangerooge is only sparsely used by Eiders during the moulting season, probably due to recreational activities (e.g. pleasure boats) (Nehls, 1999). In Denmark, a negative relationship was demonstrated between the number of moulting Eiders and the numbers of boats at sea, indicating that the Eiders avoid sites with human activity in general (Laursen et al., 1997), and specifically at mussel beds (Laursen, 2014).

Moulting Eiders are to date not systematically counted, as they cannot be separated from non-moulting birds. In Schleswig-Holstein and Lower Saxony/ Hamburg aerial counts are conducted each August; while numbers in Schleswig-Holstein have not been published yet, in the Niedersachsen Waddensea numbers from 35,000 to 101,000 have been registered between 1987 and 2014, fluctuating without a clear trend (G. Scheiffarth, unpubl.). For the remaining regions of the Wadden Sea, recent numbers do not exist.

It must be assumed that moulting and non-moulting Eiders mix in the Wadden Sea for the period July to September, which makes it difficult to identify single moulting concentrations or areas.

Common Scoters show the longest moulting period (June to October) since immature birds, males and females have consecutive moulting schedules. Disturbance effects of both offshore windfarms and ships (also maintenance traffic to offshore windfarms) are known; for example flight distances for approaching boats are more than 2,000 m (Bellebaum et al., 2006; Schwemmer et al., 2011; Dierschke et al., 2016). Recent studies have been carried out in Denmark and Germany within assessments for offshore wind farms and sand extraction.

Moulting centres of Common Scoter in all three Wadden Sea countries had been roughly identified during the late 1990s (Hennig, unpubl.); Denmark and Schleswig-Holstein hold areas with medium numbers, Lower Saxony/ Hamburg and the Netherlands those with smaller numbers (for Schleswig-Holstein see Hennig & Eskildsen, 2001; Deppe, 2003). For Schleswig-Holstein, those areas have been confirmed by recent counts during 2007/2008 and 2010 to 2012, carried out in the framework of a sand extraction project. Those counts and assessments lead to a proposal for a management plan for the Scoter in Schleswig-Holstein (Spalke et al., 2013). As moulting periods for immature differ considerably from those of adult individuals (Hennig & Eskildsen, 2001), moulting centres are not easily identified and it must be assumed that exchange of Common Scoters between these two sites takes place.

The evaluation of this target yields following points:

- From the knowledge compiled it can be concluded that undisturbed moulting sites are available, however, maybe at risk from growing pressures such as boat traffic, infrastructure projects, tourism.
- Missing comprehensive data regarding moulting concentrations of Common Eider and Common Scoter.

The evaluation cannot assess the target issues of natural populations and undisturbed connectivity.

3.3 Fluctuations in food stocks determined by natural processes

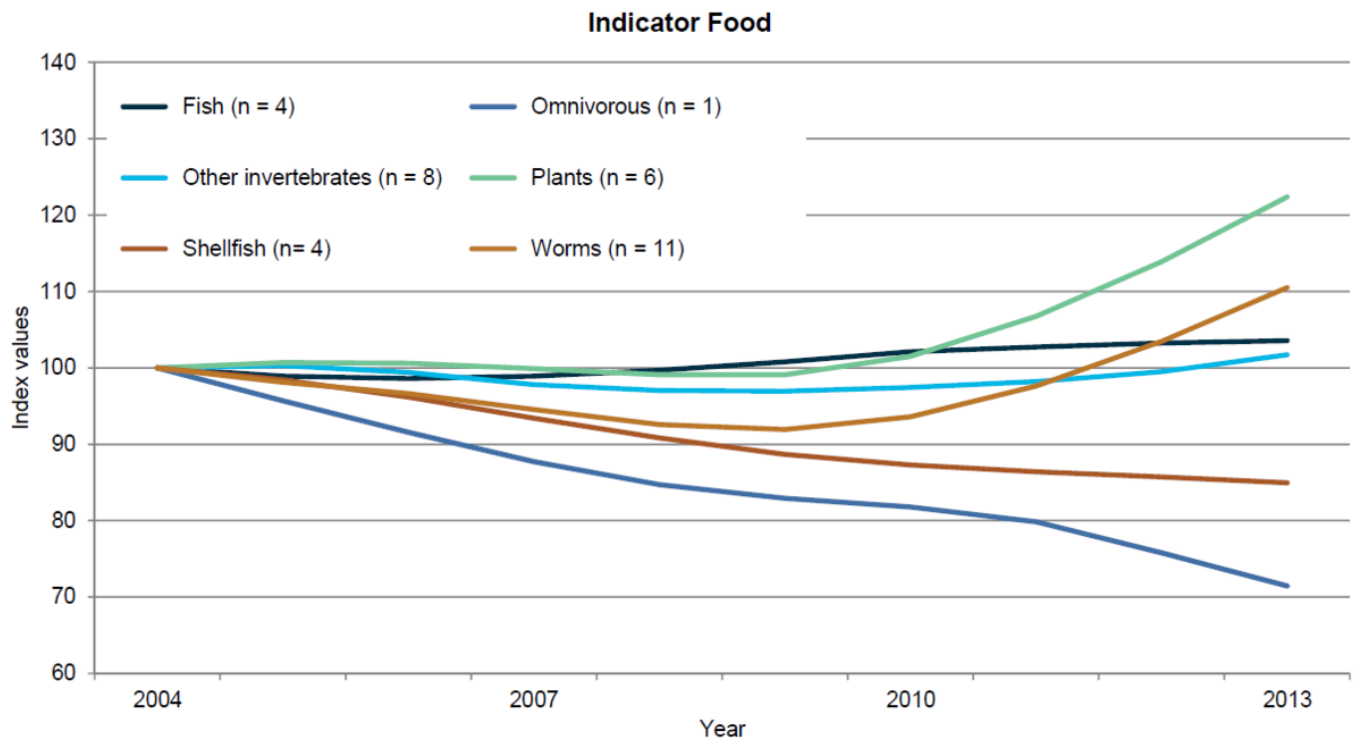
- This target “Fluctuations in food stocks determined by natural processes“ is closely linked to targets “*Feeding, moulting and roosting sites supporting a natural population*” and “*Undisturbed connectivity between feeding, moulting and roosting sites*”.

In the two recent QSR this target had been described and assessed for two main topics, “goose grazing / salt marsh management” and “benthic and shellfish feeders”.

The introduction of indicator groups (introduced in Laursen et al., 2010, and refined since Blew et al., 2013) allows to more specifically assess the population developments for species grouped according to both their main “food” and their main “feeding habitat”, respectively. In fact, both indicators should be assessed to evaluate this target.

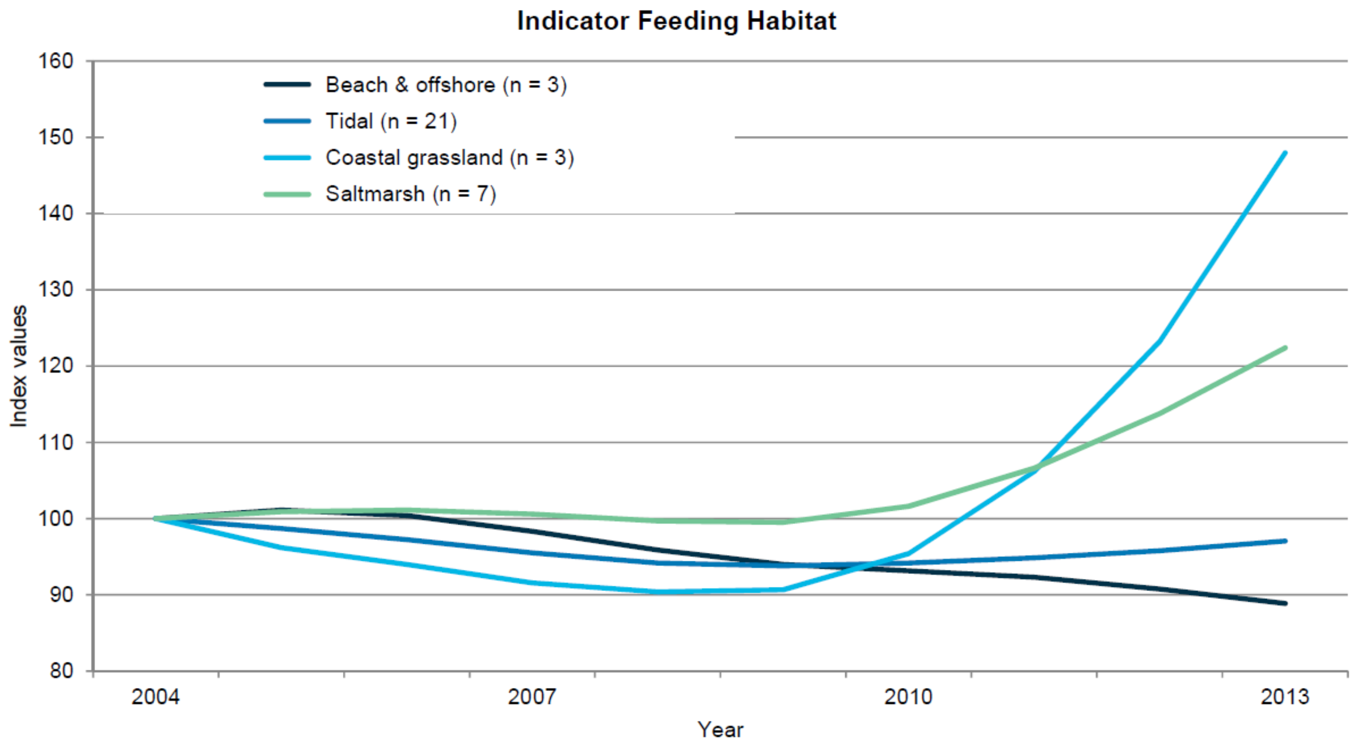
While the long-term trends inform about the population developments in the Wadden Sea over the last 27 years, the short-term trends (ten years; 2004/2005 to 2013/2014) are indicative of recent changes or impacts on these populations and thus in the focus of interpreting monitoring results. Consequently, short-term trends of the indicator groups “ food” and “feeding habitats” are chosen to assess this target; “food” will be the first to be assessed, while the results regarding “feeding habitat” will be used as additional arguments.

In Figures 4 and 5 the short-term trends of indicator groups are given as a figure while a respective table shown below the figure lists the species belonging to each indicator with the colours expressing the short-term species trends.



Shellfish	Worms / Benthos	Fish	Other invertebrates	Plants	Omnivorous
Common Eider	Pied Avocet	Great Cormorant	Common Shelduck	Barnacle Goose	Great Black-backed Gull
Eurasian Oystercatcher	Great Ringed Plover	Eurasian Spoonbill	Northern Shoveler	Dark-bellied Brent Goose	
Red Knot	Kentish Plover	Spotted Redshank	Whimbrel	Eurasian Wigeon	
Herring Gull	Eurasian Golden Plover	Common Greenshank	Eurasian Curlew	Common Teal	
	Grey Plover		Common Redshank	Mallard	
	Northern Lapwing		Ruddy Turnstone	Northern Pintail	
	Sanderling		Common Black-headed Gull		
	Curlew Sandpiper		Common Gull		
	Dunlin				
	Ruff				
	Bar-tailed Godwit				

Figure 4. Composite short-term trends 2004/2005 to 2013/2014. Top: Combined trend figures based on index values; season 2004/2005 set to "100". Bottom: Species list of the different main food. Colours according to Figure 1.



Salt marsh	Tidal area	Beach & offshore	Coastal grassland
Barnacle Goose	Great Cormorant	Sanderling	Eurasian Golden Plover
Dark-bellied Brent Goose	Eurasian Spoonbill	Ruddy Turnstone	Northern Lapwing
Eurasian Wigeon	Common Shelduck	Great Black-backed Gull	Ruff
Common Teal	Common Eider		
Mallard	Eurasian Oystercatcher		
Northern Pintail	Pied Avocet		
Northern Shoveler	Great Ringed Plover		
	Kentish Plover		
	Grey Plover		
	Red Knot		
	Curlew Sandpiper		
	Dunlin		
	Bar-tailed Godwit		
	Whimbrel		
	Eurasian Curlew		
	Spotted Redshank		
	Common Redshank		
	Common Greenshank		
	Common Black-headed Gull		
	Common Gull		
	Herring Gull		

Figure 5. Composite short-term trends 2004/2005 to 2013/2014. Top: Combined trend figures based on index values; season 2004/2005 set to "100". Bottom: Species list of the different feeding habitats. Colours according to Figure 1.

3.3.1 Plants

The six plant feeding species are Barnacle and Brent Goose, Eurasian Wigeon, Common Teal, Mallard and Northern Pintail, that is geese and duck species. The composite indicator trend "food" grouped for "plants" of the last ten years is increasing (Figure 4). This increase takes place mainly during the last five years, dominated by Barnacle, Teal and Pintail. Since 1987/1988 a stable trend exists with a period of low numbers during the late 1990s caused by the four duck species (Blew et al., 2016). All these plant feeding species use the feeding habitat "saltmarsh", plus the Northern Shoveler (food "other invertebrates") which has a stable trend; consequently both composite indicator trends "food" and "feeding habitat" trends have the same shape.

It must be concluded, that for these groups this target is met. However, the positive trends for the Barnacle Goose maybe caused by extended options for this species to gather high quality food on agricultural habitats outside the Wadden Sea and to extend their formerly breeding grounds to areas closer to the Wadden Sea areas. The development of Brent Goose is also driven by breeding success in the Arctic breeding grounds, as well as by saltmarsh management (grazing) and competition with Barnacle Goose (see Koffijberg & Günther, 2005, and discussion in the QSR 2009). The population development of the duck species will not be solely driven by the Wadden Sea quality; e.g. for Wigeon it *"seems likely that the observed flyway population trend since 1988 has been mostly influenced by climate effects on the breeding grounds affecting reproductive success and marginally on the winter quarters affecting survival."* (Fox et al., 2016).

3.3.2 Fish

The four fish feeding species are Great Cormorant, Eurasian Spoonbill, Spotted Redshank and Common Greenshank, and their composite indicator trend "fish" for the last ten years is stable, however, has seen a steady increase in the 17 years before (Blew et al., 2016). All species use the "feeding habitat" tidal area, which for Great Cormorant should be re-assessed. The species trends within this indicator group are diverse; both Cormorant and Spoonbill show long-term increasing trends, the Cormorant, however, decreases over the recent ten years. Spotted Redshank shows a long- and short-term decrease and the Greenshank a stable trend for both periods.

To assess "food availability" for fish, the quality of tidal creeks both within the saltmarshes and the tidal areas should be assessed. The contrasting trends of the four species do not allow for a sound assessment of this target. The decrease of Cormorants as migratory birds in the Wadden Sea has not been explained yet, but the breeding numbers have also recently levelled off (see report "Breeding Birds"). At least the ongoing increase of Spoonbills shows, that food availability seems not to be a limiting resource, however although here the breeding population trends is levelling off (see report "Breeding Birds"). As the diet of Spotted Redshank is not solely fish, but more diverse, the decreasing trend of this species may be be influenced by other food factors, such as e.g. the in- or decrease of *Corophium* spec. in the Dollard (Prop et al., 2012).

3.3.3. Shellfish

The decline of the four species Common Eider, Eurasian Oystercatcher, Red Knot and European Herring Gull has been reflected in the long- and short-term trends and is ongoing. Consequently, the composite indicator trend "food" for "shellfish" is also a decline, both short- and long-term. All four species are using the feeding habitat "tidal area".

The reasons for the decline of those four species are to a considerable part related to the development of the population and distribution of bivalves (Blue Mussel and Cockle) being affected by fishery management in the different Wadden Sea regions (Scheiffarth & Frank, 2005; Ens et al., 2007; Laursen et al., 2009, 2010; Kraan, 2010). The most immediate effects apply for the Common Eider, as food stocks have been depleted and alternative food stocks are not available or of low quality. For the Oystercatcher, two hard winters may have additionally or in combination contributed to lower staging numbers (e.g. mass mortality in February 2012 – Schwemmer et al., 2014). For the Red Knot, these food resource issues contribute to partial declines (Kraan et al., 2010), but further reasons are to be found also in the wintering grounds (Leyrer et al., 2016). For Herring Gull, mussel fishery may provide only part of the explanation for the lower numbers, as this species also makes use of other food resources.

Concluding, however, the ongoing decline of these four species must be attributed to a considerable part to the lack and poor quality of the shellfish resources which fluctuations are not solely determined by natural processes but also by commercial exploitation; this target is not met.

3.3.4 Omnivorous

Only one species, the Great Black-backed Gull belongs to this indicator. Its decline can neither be explained by the issue “food availability”, nor by the issue “feeding habitat” which is “beach & offshore”.

3.3.5 Worms / Benthos

Eleven species, that is Pied Avocet, Common Ringed Plover, Kentish Plover, European Golden Plover, Grey Plover, Northern Lapwing, Sanderling, Curlew Sandpiper, Dunlin, Ruff and Bar-tailed Godwit, belong to this group, and thus 11 of the total number of 19 wader species. Of those, seven species use tidal areas, while three species, namely Golden Plover, Northern Lapwing and Ruff use coastal grasslands as their main feeding habitat; Sanderling uses many different types of tidal flats and beaches, depending of the period of the year.

The composite indicator trend of this group is stable for the last ten years, but has seen a steady decline between 1992 and 2010. Besides the identified problem of the shellfish resources, it was mainly this decline of a number of typical Wadden Sea wader species, which triggered the project “Exploring contrasting trends of migratory waterbirds in the Wadden Sea” (Ens et al., 2009). By that time, most of these species were declining in Germany and thus in the central part of the Wadden Sea, while stable and increasing trends had been observed in the Netherlands and in Denmark, here with smaller overall numbers (van Roomen et al., 2012). This finding and the contrasting trends between regions and tidal basins within the Wadden Sea suggest that causes of the unequal changes in numbers are mainly to be sought within the Wadden Sea itself. Interestingly, the Wadden Sea regions where negative trends of benthivorous waterbirds predominate are characterized by a large tidal amplitude, whereas areas where bird numbers have generally increased are characterized by a small tidal amplitude (Laursen et al., 2009).

To date, only Pied Avocet and Dunlin have decreasing trends, while e.g. Common Ringed Plover increases, Grey Plover and Bar-tailed Godwit are stable. The variety of species, trends and possible causes does not allow a comprehensive overview or an in-depth analysis.

An inventory of possible causes indicated climate change, eutrophication, shellfish fisheries, invasive species and increasing numbers of avian predators as the most important candidates to be investigated further to explain the observed trends (van Roomen et al., 2012).

3.3.6 Other invertebrates

The eight species feeding on “other invertebrates” are Common Shelduck, Northern Shoveler, Whimbrel, Eurasian Curlew, Common Redshank, Ruddy Turnstone, Common Black-headed Gull and Common Gull. Six of these species feed in the tidal areas, the Northern Shoveler uses salt-marshes and the Ruddy Turnstone beach areas as feeding habitats.

The composite indicator trend of this group is stable, and has not changed since 1995, when it had dropped from a higher stable level (Blew et al., 2016). Of this group, only the Common Redshank is decreasing, while all other species have stable trends.

The food "other invertebrates" separates this group from the "worms / benthos" group, however, this way it includes both a large variety of food items / invertebrate groups as well as bird species, such as ducks, waders, and gulls. An assessment of this group is difficult, as it has not yet been investigated in-depth and regards too many different aspects. A general conclusion, however, is, that the stable trend of the indicator group and the single species does not raise an alarming signal.

3.3.7 Target evaluation

Regarding "food availability", for the food groups "shellfish" and "worms / benthos" the target has not been met, for the food groups "plants" and "fish" it seems the target has been met. For the remaining two groups ("omnivorous" and "other invertebrates") the results are inconclusive.

Considering the recent target "*fluctuations in food stocks determined by natural processes*", for most food groups this issue cannot be assessed with the exception of shellfish, for which it is clear, that commercial exploration causes fluctuations.

4. Recommendations

4.1 Stable or increasing numbers and distribution - Development of trends

4.1.1 Recommendations for monitoring and research

The current monitoring of migratory birds is well able to keep track on changes of most migratory bird populations in the Wadden Sea since 1987/1988; with 27 years of monitoring, these data are of great value for many aspects of migratory bird ecology within the Wadden Sea. Some of the monitored species occur in very small numbers or with very small proportions of their larger populations (e.g. Kentish Plover, Curlew Sandpiper, Ruff); for these species counted numbers may vary so much, that trend assessments are not possible.

The process of data retrieval, processing and trend calculations has proved to be efficient over the last ten years. Results of the monitoring are published annually in progress reports and are made available online by the Common Wadden Sea Secretariat; this way they are easily shared among the Wadden Sea community and other relevant institutions.

A new feature of further exploring migratory bird trends has been the definition and use of the ecological guild groups "food", "feeding habitat", "breeding grounds" and "wintering grounds" which allow analyses of composite indicator trends (Blew et al., 2016). For this QSR use has been made of the first two groups "food", "feeding habitat" to assess the Wadden Sea Plan target "*fluctuations in food stocks determined by natural processes*". This exercise has been both successful and limited, respectively. Above all, the trend developments are only able to signalize patterns; they are not able to explain causes and could only address further research.

- It is desirable to shorten the time-lag between data collection and year of publication, which at the moment is two to three years. For example the input of the field data maybe accelerated by using online methods with a still rigid quality assurance; this may exist in some regions but not in others. If the time lag between counts and results is shortened, more actual data could be presented for managers in the annual reports, which would enhance feedback to all participating observers who contribute to the collection of the field data; these are often volunteers, for which feedback is essential to continue participation.
- Making better use of the fine temporal resolution of the spring tide count data would improve analyses of peak occurrences and staging periods. Spatial distribution should be shown in maps of the entire Wadden Sea including trend information for the 29 sub-areas.
- The existing data collection on age ratios (e.g. goose counts in November) has up to date not been used for further analyses. To include further species groups, analyse the data and to monitor further “vital rate” data / demographic parameters could greatly improve interpretation of monitoring data beyond the bare numbers (e.g. Fox *et al.*, 2016).
- In recent years, data for five species have been analysed separately for geographic populations based on assumptions about different occurrence periods in the Wadden Sea; these data have not been analysed further, but are only presented in the progress reports.
- The interpretation of Wadden Sea trends should also include to put these trends into perspective with the East Atlantic Flyway trends and identify potential interactions between these (see report "East Atlantic Flyway").
- At the species level, the combination with the breeding bird data could further help to concentrate on one or the other time period of those species; e.g. both Oystercatcher and Pied Avocet have decreasing breeding and migrating populations and causes of these declines are most likely to be found in the Wadden Sea, an interdisciplinary approach is desirable (see report "Breeding Birds").
- Strengthen the approach of monitoring, also in a wider context (e.g. OSPAR / MSFD). Compare and assess monitoring results in a larger regional context including entire flyways (see report "East Atlantic Flyway").
- Connect the bird counts to other TMAP parameters. Recent analyses have shown that for many questions basic environmental data is missing or not available.

4.1.2 Recommendations for management

- none

4.2 Roosting and moulting sites supporting a natural population; undis-turbed connectivity

4.2.1 Recommendations for monitoring and research

- Re-assess the quality of high tide roosting sites including monitoring of disturbance sources;
- Assess the effects of hunting of birds and small mammals at saltmarshes and inland roosting sites;
- Assess potential effects of the proposal of “sustainable use” = hunting of species with high population numbers such as Barnacle Goose;
- Assess the effects of a growing presence of Peregrine Falcons and other birds of prey;
- Include Peregrine Falcon and further birds of prey species in both monitoring and analysing high tide roost counts.

- Include outer sands in both monitoring and analysing high tide roost counts in the Netherlands and Germany.
- Re-start the trilateral monitoring program for moulting Common Shelduck, with aerial counts in the Dutch Wadden Sea.
- Initiate a monitoring program for moulting concentrations of Common Eider and Common Scoter.
- Investigate macrozoobenthos communities in the offshore area as food for the Common Scoter (from QSR 2009).

4.2.2 Recommendations for management (all but the last taken from QSR 2009)

- Further develop spatial and temporal zoning for recreational activities.
- Acquire more information on natural flight distances (monitoring and research) when managing public access close to roosting sites.
- Assess impact of ultra light aircraft.
- Assess impact of small boats and canoes that have become popular and are able to sail in areas where the water depth is only a few centimetres.
- Provide sufficient protection to high tide roosts not included in designated SPA; especially a problem in The Netherlands.
- Evaluate potential disturbance from offshore wind farms and the associated ship traffic, with special attention for offshore moulting common scoters.
- Compile and assess studies and results to hunting effects in protected areas.

4.3 Fluctuations in food stocks determined by natural processes

4.3.1 Recommendations for monitoring and research

- Refine guild groups to more accurately describe and follow trend developments in light of certain ecological circumstances (to answer the question: which species groups would collectively benefit from targeted management measures).
- A renewed assessment of the current situation of mussel fishery and stocks is necessary, also under the light of new developments regarding regulations on account of the Habitat Directive.
- Include parameters (from a birds point of view) for benthos mass and benthos quality in the TMAP to facilitate assessment of bird numbers and their changes;
- Assess causal relationships between occurrence of birds and the availability of food stocks;
- Assess changes in distribution of geese in relation to changes in salt marsh management;
- Initiate studies of the origin/breeding areas of the bird populations using the Wadden Sea, thus allowing an improved assessment for changes observed (see report "East Atlantic Flyway");
- Assess the value of low tide counts.

4.3.2 Recommendations for management (taken from QSR 2009 and slightly modified)

- Actualize the evaluation of changes in the extent and method of shellfish fishery.
- Monitor the shellfish fishery including the seed fishery and the impact on bird species.
- Harmonise methods used for assessing and monitoring shellfish stocks.

The former three recommendations could be combined into one on monitoring of shellfish fishery and birds.

5. Summary

For migratory birds belonging to the East Atlantic Flyway the Wadden Sea is of great importance as a staging, wintering and moulting area. Monitoring and population development calculations in the entire Wadden Sea take place for 27 years now and for at least 39 populations of 34 migratory waterbird species

The comparison of the trends as published in the three QSRs from 2004, 2009 and 2016 shows (Figure 2):

- in the long-term trends the number of decreasing species went from five over 13 to now 16 species, while in the short-term trend the number of species with decreasing trends went from 15 in 2004, to twelve in 2009 and to eleven in 2016;
- in turn, the number of species with an increasing long- and short-term trend became less in comparison to 2009.

Three QSR assessments showed that four species have been always increasing, namely Cormorant, Spoonbill, Barnacle Goose and Common Ringed Plover. On the other hand, ten species have been decreasing in those assessments, namely Mallard, Eider, Oystercatcher, Avocet, Golden Plover, Ruff, Spotted Redshank and Black-headed, Herring and Great Black-backed Gull. This represents a loss of some 500,000 migratory birds in the International Wadden Sea. The target of "*stable or increasing numbers*" is clearly not met.

The recently initiated Wadden Sea Flyway Initiative (WSFI) expanded data collection and analyses to the East Atlantic flyway level (see report "East Atlantic Flyway"). Those flyway trends can be compared to the Wadden Sea trends (Figure 1); current analyses assesses that for many species reasons for negative trends may rather be present within the Wadden Sea than on the flyway.

Regarding the target "*Feeding, roosting and moulting sites supporting a natural population; undisturbed connectivity between feeding, roosting and moulting sites*" the following assessments are made:

- the quality of high tide roosting sites cannot be sufficiently assessed, as the most recent evaluation goes back to 2003 (Koffijberg et al., 2003) and some issues like tourism, infrastructure (e.g. wind parks) and others have changed;
- the proposal of "sustainable use" = hunting of species with high population numbers has the potential of affecting the roosting site quality;
- missing data as e.g. (aerial) counts of remote islands / sand banks lower the quality of the trend assessments.

In addition, the increasing numbers of raptors breeding in or near the Wadden Sea, here Peregrine Falcon and White-tailed Eagle, have been recently assessed regarding potential "quality" of roosting sites. However, as the target explicitly mentions "*roosting sites supporting a natural population*", this target is not directly affected, but the need for a sufficient number of good quality roosting sites must be highlighted once again.

Regarding the target of "*moulting sites*" the two species Eider Duck and Common Scoter are in focus. The evaluation of this target yields following points:

- From the knowledge compiled it can be concluded that undisturbed moulting sites are available, however, maybe at risk from growing pressures such as boat traffic, infrastructure projects, tourism.
- Missing comprehensive data regarding moulting concentrations of Common Eider and Common Scoter.

To assess the target "*Fluctuations in food stocks determined by natural processes*" species trends have been pooled as indicators for either "*food*" or "*feeding habitat*".

Results show that for the food groups “*shellfish*” and “*worms / benthos*” the target has not been met, for the food groups “*plants*” and “*fish*” it seems the target has been met. For the remaining two groups (“*omnivorous*” and “*other invertebrates*” the results are inconclusive.

Considering the target “*fluctuations in food stocks determined by natural processes*”, for most food groups this issue cannot be assessed with the exception of shellfish, for which it is clear, that commercial exploration causes fluctuations of migratory bird populations.

A number of recommendations have been concluded for each target. Most important points are, that data analyses is thorough but may profit from additional counts at remote sites and further efforts on the flyway level, both at the breeding and wintering grounds, respectively. Site management should strive to keep and improve the number of good quality roosting and moulting sites and may need renewed assessment. Additional efforts should be started and strengthened to also monitor food stocks (shellfish, benthos) to further understand the ecological causes of migratory bird trends.

About the authors

J. Blew[1,8], K. Günther[2,8], B. Hälterlein[3,8], R. Kleefstra[4,8], K. Laursen[5], J. Ludwig[7,8], G. Scheiffarth[6,8]

[1] BioConsult SH, Schobüller Str. 36, 25813 Husum, DE

[2] Schutzstation Wattenmeer, Nationalparkhaus Husum, Hafenstrasse 3, 25813 Husum, DE

[3] National Park Authority Wadden Sea Schleswig-Holstein, Schlossgarten 1, 25832 Tönning, DE

[4] Sovon, Dutch Centre for Field Ornithology, Toernooiveld 1, 6525 ED Nijmegen, NL

[5] Aarhus University, Nordre Ringgade 1, 8000 Aarhus C, DK

[6] National Park Authority Wadden Sea Lower Saxony, Virchowstr. 1, 26382 Wilhelmshaven, DE

[7] Staatliche Vogelschutzwarte at Lower Saxon State Department for Waterway, Coastal and Nature Conservation (NLWKN), Am Sportplatz 23, 26506 Norden, DE

[8] Joint Monitoring Migratory Bird Group (JMMB) c/o Common Wadden Sea Secretariat, Virchowstr. 1, 26382 Wilhelmshaven, DE

Acknowledgements

In Denmark the counts in the Wadden Sea was organised by Wildlife Administration at Kalø up to 1990. Thereafter the National Environmental Research Institute (NERI), Department of Flora and Fauna Ecology took over. In 2007 NERI merged with Aarhus University and the Department of Coastal Zone Ecology was responsible for the monitoring. In 2011 DCE-National Centre for Energy and Ecology- under Aarhus University became responsible for the monitoring program. The monitoring of the Wadden Sea became a part of the Danish national monitoring program NOVANA in 2004.

In Schleswig-Holstein the monitoring was initiated by the Ornithological Society Schleswig-Holstein (OAG SH) in the 1960s; regular monitoring was jointly organized by the OAG SH and the World Wide Fund for Nature (WWF) in 1987 and during the first period until 1994 funded by the federal state Schleswig-Holstein and the Federal Ministry of Environment (Federal Environment Agency) as part of an ecosystem research project. Since then it was funded by the National Park Administration Schleswig-Holstein Wadden Sea. The coordination of the project moved from WWF to the Schutzstation Wattenmeer e.V. in 2004. The aerial surveys of Common Eider and Shelduck were separately financed by the National Park Administration Schleswig-Holstein Wadden Sea.

In Hamburg counts were organized by the Hamburg Wadden Sea National Park.

In Niedersachsen the counts were organized by the Bird Conservation Station in the Lower Saxony Water Management, Coastal Defence and Nature Conservation Agency (NLWKN), formerly Lower Saxony Agency for Ecology (NLÖ). The aerial surveys of Common Eider were financed by the Lower Saxony Wadden Sea National Park Authority.

The waterbird counts in the Dutch Wadden Sea are part of the national monitoring program of waterbirds in the Netherlands, which is a cooperation between the Ministry of Agriculture, Nature and Food Quality, the Ministry of Water Management and Public Works, Statistics The Netherlands (CBS), Vogelbescherming Nederland and Sovon Dutch Centre for Field Ornithology. The aerial surveys of Common Eider in winter were carried out under the responsibility of the Ministry of Water Management and Public Works.

Erik van Winden (Sovon, the Netherlands) performed the UINDEX and TrendSpotter operations to calculate trends and to provide the imputed numbers for the calculation of maximum estimates and distributions.

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