Migratory Waterbirds in the Wadden Sea 1980 – 2000

Colophon

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Editorial Foreword

We are very pleased to present the results of the twenty-year period 1980 - 2000 of the Joint Monitoring on Migratory Birds in the Wadden Sea (JMMB), which is carried out in the framework of the Trilateral Monitoring and Assessment Program (TMAG), in the 20th issue of the Wadden Sea Ecosystem series

This report succeeds the two reports on joint activities in the field of migratory bird monitoring in 1992/93 (Rösner *et al.*, 1994) as well as in 1993/94 (Poot *et al.*, 1996). In 1994, the evaluation of international Wadden Sea birds counts in the period 1980 - 1991 was published by Meltofte et al., 1994. Besides these issues on results of migratory birds monitoring, a review on important and potential roosting sites in the Wadden Sea were published by the JMMB in 2003. The results of all these reports and further recent data have been taken into account in the compilation of trends in this report.

The present report entails four contributions. In the first and main one, the JMMB gives an overview of numbers and trends 1980 - 2000 for all 34 species of the JMMB-program. Regarding selected species respectively species groups - such as Barnacle Geese and Dark-bellied Brent Geese, Curlews as well as shellfish-eating birds - specific aspects related to habitat use, hunting and mussel and cockle fishery are discussed in more detail by different authors in the following three additional contributions of the issue.

We would like to thank all those who contributed with great effort to the surveys and the preparation of the report, mainly the numerous field workers and their organizations, the national coordinators of the JMMB-program as well as the authors of the report. Our particular thanks go to Jan Blew, the lead author, who took care of handling and analyzing the data as well as compiling and writing the report.

Bettina Reineking
Common Wadden Sea Secretariat
September 2005

WADDEN SEA ECOSYSTEM No. 20

Overview of Numbers and Trends of Migratory Waterbirds in the Wadden Sea 1980 – 2000

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2005
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In Denmark the counts were carried out by The National Environmental Research Institute (NERI); Lars Maltha Rasmussen was the national co-ordinator from 1994 to 2002 and thereafter Karsten Laursen. Ole Thorup, Kim Fischer, Jens Peder Hounissen and Jens Ryge Petersen carried out a large part of the counts. Aerial counts were carried out by NERI up to 1992, and during the years after they were organised in a collaboration by NERI and Ribe County and performed by John Frikke.

In Schleswig-Holstein the „Monitoring of Migratory Waterbirds in the Wadden Sea" was - for the period covered by this report - coordinated by the WWF-Projektbüro Wattenmeer in Husum. The responsible persons were Hans-Ulrich Rösner (until 1996) and Klaus Günther (since then). The monitoring was funded by the „Landesamt für den Nationalpark Schleswig-Holsteinisches Wattenmeer", Tönning, and during the first period until 1994 as part of an ecosystem research project also funded by the „Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit". The aerial surveys of Common Eider and Shelduck were carried out by G. Nehls, J. Meißner, N. Kempf and G.

Scheiffarth and also financed by the „Landesamt für den Nationalpark Schleswig-Holsteinisches Wattenmeer". In Schleswig-Holstein, thanks goes out to several organisations (NGOs) and institutions, who co-operated and supported the monitoring over many years and provided thousands of counts, in particular Schutzstation Wattenmeer, Verein Jordsand, Naturschutzbund Deutschland, Naturschutzgesellschaft Sylt, Öömrang Ferian, Amt für Ländliche Räume, FTZ Büsum (University of Kiel) and the Nationalpark Service of Schleswig-Holstein. The counts were mainly conducted by young people doing their one year national service or „Freiwilliges Ökologisches Jahr (FÖJ)" at the different NGO's and since 1996 also by rangers of the Nationalpark Service. Most of the data input was done by volunteers doing their FÖJ at the WWF-Projektbüro Wattenmeer to whom we say our special thanks.

In Niedersachsen and the Hamburg regions the counts were organised by the Staatliche Vogelschutzwarte – Fachbehörde für Naturschutz, Niedersächsisches Landesamt für Ökologie. Most counts were organized by local or regional organisations and institutions, in particular the Niedersächsische Landesbetrieb für Wasserwirtschaft und Küstenschutz (NLWK) in Norden, Der Mellumrat in Varel, the Wissenschaftliche Arbeitsgemeinschaft für Natur- und Umweltschutz (WAU) in Jever, the Ornithologische Arbeitsgemeinschaft Oldenburg (OAO) in Oldenburg, Verein Jordsand in Ahrensburg, Landkreis Stade, Zählergruppe Osnabrück, Zählergruppe Dollart. The aerial surveys of Common Eider were carried out by G. Nehls, B.-O. Flore and G. Scheiffarth and financed by the National Park Administration, Niedersachsen. While many counting data are delivered in digital formats, Jan Gottwald carried out the data input from counting sheets. Jan Blew did a great deal of the data handling and analyses.

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, Ministry of Water Management and Public Works, Statistics the Netherlands (CBS), Vogelbescherming Nederland and SOVON Dutch Centre for Field Ornithology. The counts were coordinated by Ben Koks (SOVON), the data were handled and supplied by Erik van Winden (SOVON). The regional coordination of counts is taken care of by J. van Dijk (Noorderhaaks), C.J. Smit (Texel), P. de Boer (Vlieland), B. Koks (Richel), M. van Roomen (Terschelling), J. De Jong (Blauwe Balg), K. van Scharenburg (Ameland), H. Smit (Engelsmanplaat), K. van Dijk (Schiermonnikoog), V. van de Boon (Simonszand), N. de Vries & B. Corté (Rottumerplaat en Rottumeroog), J. Veen (Griend), H. de Boer (Dollard), Erik Schothorst & D. Veenendaal (mainland coast Groningen), S. Boersma & M. Engelmoer (mainland coast Friesland), P. Zomerdijk (Afsluitdijk), T. Mulder & W. Tijsen (Wieringen), M. Otter & J. Zijp (Balgzand) and C. De Graaf (Den Helder). The aerial surveys of Common Eider were carried out under responsibility of the National Institute for Coastal and Marine Management (RIKZ).

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Summaries

Summary

The Wadden Sea with 4,500 km² of intertidal flats and adjacent salt marshes and grassland polders along the North Sea coast of the Netherlands, Germany and Denmark constitutes one of the World's most important wetlands to migratory waterbirds and the single most important staging, moulting and wintering area for waterbirds on the East Atlantic flyway. According to the 1% criterion of the Ramsar-Convention, the Wadden Sea is of outstanding international importance as a staging, moulting and wintering area for at least 52 populations of 41 migratory waterbird species that use the East Atlantic flyway and originate from breeding populations as far away as northern Siberia or Northeast Canada. Numbers of 44 populations of 34 species are so high, that the Wadden Sea can be considered as their indispensable and often main stepping stone during migration, or as their primary wintering or moulting habitat.

In recent decades, the amount and quality of migratory waterbird data has increased considerably. The current "Joint Monitoring of Migratory Birds" (JMMB) program, carried out in the framework of the "Trilateral Monitoring and Assessment Program" (TMAP), consists of 2-3 internationally synchronous (complete) counts each year and bi-monthly counts during spring tide at numerous sample sites. For the first time, trends of the most numerous species have now been calculated, separately for the winter, the main migration periods and the entire year.

Adding up the numbers results in a maximum of some 6.1 million birds present in the Wadden Sea; considering turnover, this numbers may be as high as 10-12 million birds per year. Besides Cormorant and Spoonbill, those numbers are 1.66 million ducks and geese, 3.36 million waders and 0.96 million gulls. Most species reach highest numbers during autumn migration; numbers of waders are almost as high during spring, whereas ducks and geese overwinter in high numbers; only gulls reach considerable numbers in summer. Almost the entire population of the Dark-bellied Brent Goose (*Branta b. bernicla*) and the entire West-European population of Dunlin (*Calidris alpina*) use the Wadden Sea during several periods of the annual cycle. Additional seven species are present with more than 50% and further 14 species with more than 10% of their flyway population. Wadden Sea areas including the coastal zone of the adjacent North Sea are used by high numbers of moulting Shelduck (*Tadorna tadorna*) and moulting and wintering Eider (*Somateria mollissima*).

Trends in winter are based on the international synchronous counts in January and are also used for international comparisons with regard to the relevant flyway populations. During January, 25 species are present in the Wadden Sea with peak numbers higher than 1,000 individuals, overwintering with varying proportions of their populations. For most of these species, winter weather acts as an important factor; cold winters initiate pronounced winter movement towards more southern areas and an increased winter mortality for some species. The number of mild winters has been increasing over the long-term period 1980-2000, leading to increasing numbers of waterbirds overwintering in the international Wadden Sea. Considering the effects of climate change (more frequent mild winters) and thus change of food resources, wintering numbers, local trends and distribution in the Wadden Sea and on flyway level might change for some species in the future.

During the main migration periods in autumn and spring, when the Wadden Sea serves as a migration, staging and roosting habitat, weather influences are not as large as during the winter, when species may "decide" to stay or leave the area. Given are the results of the overall trends, which integrate the trends of all important migration months over the entire yearly cycle. Of the 34 species, for which the Wadden Sea represents a major stepping stone during migration, 15 species (44%) show significant decreases, seven species (21%) show non-significant decreases, three species (9%) show significant increases, one species (3%) shows a non-significant increase and eight species (23%) are overall fluctuating.

The causes for the observed population declines are not known in detail for all species, and cannot be assessed by monitoring alone. At least for Dark-bellied Brent Goose, there is a clear relationship with poor breeding seasons. For several shellfish specialists (*e.g.* Eider, Oystercatcher *Haematopus ostralegus*, but maybe also Knot *Calidris canutus* and Herring Gull *Larus argentatus*), there is evidence that food availability has deteriorated in the past decades, probably owing to a combination of reasons caused by the fishery and the climate (in this case lack of cold winters). Many of the other declining species, however, are those for which more than 50% of the total flyway population migrate through or stay within the Wadden Sea, and have also in common that they are long-distance migrants and their lifetime strategy includes a period of fast refuelling during their migration to the breeding or the wintering grounds; to them, the Wadden Sea is of fundamental importance

as a large and almost inexhaustible food source. Since the declining numbers for most of these species have not been confirmed elsewhere in Europe, the underlying causes for the downward trends are assumed to be connected to the situation in the Wadden Sea itself; however, regional differences in the trends might exist with some decreases occurring mainly in the German Wadden Sea. More ecological research is needed to understand and reverse the negative trends which have been detected. Compared to the numerous species showing declines, rather few species show significant upward overall trends. Those are Cormorant (*Phalacrocorax carbo sinensis*), Spoonbill (*Platalea leucorodia*) and Barnacle Goose (*Branta leucopsis*), all species which have been experiencing increases of their respective flyway populations in the past decade.

With regard to the migratory waterbird species in the international Wadden Sea, we are able to produce sound results regarding their population status and thus fulfil obligations deriving from the European directives (Bird Directive, Habitat Directive, Water Framework Directive). Through the cooperation among the trilateral Wadden Sea countries, facilitated by the JMMB, data from the international Wadden Sea have been compiled and have been analysed with regard to total numbers and trends. The trend analyses methods applied have proven to produce reliable trend results; however, longer data series would largely improve the accuracy of those trends and trend methods can still be refined. Monitoring programs must ensure, that data exchange, comparison and causal analyses are possible and are able to include other groups of organisms and ecological parameters in order to further describe and strive for the favourable conservation status for the international Wadden Sea.

Sammenfatning

Vadehavet udgør med 4.500 km^2 tidevandsflader og tilstødende strandenge og marskområder langs med Nordsøens kyster af Holland, Tyskland og Danmark et af verdens mest værdifulde vådområder for trækkende vandfugle og et enestående vigtigt raste, fælde og overvintringsområde for vadefugle på den østatlantiske flyway. I henhold til 1% kriteriet i Ramsar konventionen er Vadehavet af enestående international betydning som et raste-, fælde og overvintringsområde for mindst 52 bestande af 41 trækkende vandfuglearter på den østatlantiske flyway og stammer fra ynglebestande så langt borte som det sydlige Sibirien og nordøstlige Canada. Antallet af 44 bestande fra 34 arter er så højt at Vadehavet kan betragtes som detvigtigste område under trækket, eller deres primære overvintring eller fældelokalitet.

Igennem de sidste årtier er mængden og kvaliteten af data for trækkende vandfugle steget betydeligt. Det løbende JMMB-overvågningsprogram (Joint Monitoring Group of Migratory Birds) som udføres inden for rammerne af det fælles overvågningsprogram(Trilateral Monitoring and Assessment Program), består af 2-3 internationale synkrone (komplette) tællinger hvert år og 14-dages tællinger ved springflod på et stort antal tællelokaliteter. For første gang er udviklingen for de talrigeste arter beregnet for henholdsvis vinterperioden, arternes hovedtrækperiode og for hele året.

Når alle resultaterne sammenlægges resulterer det i at omkring 6,1 mio. fugle befinder sig i Vadehavet; hvis man dertil beregner hvor mange fugle der passerer gennem Vadehavet i løbet af et år stiger tallet til 10-12 mio. fugle. Foruden Skarv og Skestork udgøres de nævnte fugle af 1,66 mio. gæs og ænder, 3,36 mio. vadefugle og 955,000 måger. De fleste arter når op på det største antal om efteråret. Antallet af vadefugle er også næsten lige så højt om foråret, hvorimod gæs og ænder overvintre i et stort antal; kun måger når betydelige antal om sommeren. Næsten hele bestande af Mørkbuget Knortegås (*Branta b. bernicla*) og hele bestanden af Almindelig Ryle (*Calidris alpina*) bruger Vadehavet i flere perioder om året. Det samme gælder for syv arter hvor mere end 50% af bestanden raster i Vadehavet og for 14 arter som er til stede med mere end 10% af deres trækrute bestand. Vadehavet inklusiv den tilstødende zone af Nordsøen bruges af et stort antal fældende Gravænder (*Tadorna tadorna*) og fældende og overvintrene Ederfugle (*Somateria mollissima*).

Beregning af udviklingstendenser er baseret på de internationale, synkrone tællinger i januar og bruges også til de internationale sammenligninger for de relevante flyway bestande. I januar er 25 arter til stede i Vadehavet med maksimumsantal som overstiger 1,000 individer, som overvintrer med varierende andele af deres bestande. For de fleste af disse arter, er vintervejret en vigtig parameter. Kolde vintre forårsager omfattende træk mod mere sydlige områder og en stigende vintermortalitet for nogle arter. Antallet af milde vintre har været stigende gennem perioden 1980-2000, hvilket har givet anledning til stigende antal overvintrene vandfugle i Vadehavet. Dette er højst sandsynligt regionale udviklingstendenser som vedrører Vadehavet, men som også påvirker vinterfordelingen på arternes flyway niveau. Ef-

fekten af klimaændring (flere hyppige milde vintre) og dermed ændring af føde ressourcer, antal fugle om vinteren, lokale udviklingstendenser og fordeling i Vadehavet og på flyway niveau kan medføre at antallet af fugle for nogle arters vedkommende bliver ændret i fremtiden.

I arternes hovedtrækperiode om efteråret og foråret, når Vadehavet tjener som en træk- og rastelokalitet er indflydelsen af vejret ikke så stor som om vinteren, hvor arterne må 'beslutte' sig til at blive eller forlade området. I rapporten præsenteres resultaterne for de overordnede udviklingstendenser, som – afhængig af de pågældende arters trækmønstre – kan blandes med udviklingstendenserne for forår og efterår eller begge årstider. Af de 34 arter for hvilke Vadehavet repræsenterer en væsentlig lokalitet under trækket, viser 15 arter (44%) signifikante nedgange, yderligere 7 arter (21%) viser ikke signifikante nedgange, 3 arter (9%) viser signifikante stigninger, 1 art (3%) viser en ikke signifikant stigning og 8 arter (23%) er overvejende fluktuerende.

Årsagerne til de observerede bestandes fald i antal kendes ikke i detaljer for alle arter, og kan ikke vurderes ud fra overvågningsdata alene. I det mindste for Mørkbuget Knortegås, er der en klar relation til dårlige ynglesæsoner. For adskillige muslinge-specialister (f.eks. Ederfugl, Strandskade *Haematopus ostralegus*, men måske også for Islandsk ryle *Calidris canutus* og Sølvmåge *Larus argentatus*), er der belæg for at fødetilgængeligheden er forringet i de sidste ti år, sandsynligvis skyldes det en kombination af årsager hvori indgår muslingefiskeri og klima (i denne sammenhæng mangel på kolde vintre). Mange af de øvrige arter, der er faldet i antal, er arter som for mere end 50% af flyway bestanden bruger Vadehavet som rastelokalitet og som desuden har det til fælles at de er langdistance-trækkere og deres livsstrategi omfatter en periode med hurtig fødeindtagelse under trækket til yngleområderne eller overvintringsområderne. For dem er Vadehavet af fundamental betydning som et område med en stor og næsten uudtømmelig føde ressource. Da de faldende antal for de fleste af disse arter ikke er bekræftet andre steder i Europa, antages det at de er knyttet til forholdene i Vadehavet. Dog er der regionale forskelle med antalsmæssige nedgange især i det tyske Vadehav. Mere økologisk forskning er derfor nødvendig for at forstå og ændre den negative udvikling som er beskrevet. Sammenlignet med de talrige arter som udviser negative tendenser, viser forholdsvis få arter en stigende tendens. Disse er Skarv (*Phalacrocorax carbo sinensis*), Skestork (*Platalea leucorodia*) og Bramgås (*Branta leucopsis*). Alle arter som har vist stigende bestande inden for deres trækområder gennem de sidste ti år.

Ud fra data for trækkende vandfugle i Vadehavet er vi i stand til at producere gode resultater med hensyn til bestandenes status og dermed opfylde de forpligtigelser som er nævnt i EU-direktiverne (EF-fuglebeskyttelsesdirektivet, Habitatdirektivet, Vandrammedirektivet). Gennem det Trilaterale Vadehavssamarbejde er det muligt for de tre lande, via JMMB, at sammenstille data fra Vadehavet og analysere dem med hensyn til arternes totale antal og udviklingstendenser. Den anvendte metode til analyse af udviklingstendenserne har vist sig i stand til at give pålidelige resultater om arternes udvikling. Men længere dataserier vil forbedre sikkerheden for beregning af disse tendenser betydeligt, og analysemetoderne kan stadig forbedres. Overvågningsprogrammer må sikre, at data kan udveksles, at de er sammenlignelige og at kausale analyser kan udføres for andre artsgrupper end fugle og at økologiske parametre kan inddrages for yderligere at kunne beskrive sammenhænge og bruge denne viden i bestræbelserne på at sikre Vadehavet en gunstig bevaringsstatus.

Zusammenfassung

Das Wattenmeer entlang der Nordseeküste der Niederlande, Deutschlands und Dänemarks ist mit seinen 4.500 km² Wattfläche und den angrenzenden Salzwiesen, Poldern und Kögen eines der bedeutendsten Feuchtgebiete der Welt für rastende Wasser- und Watvögel und das wichtigste zusammenhängende Gebiet auf dem Ostatlantischen Zugweg. Bezogen auf das 1%-Kriterium der Ramsar-Konvention ist das Wattenmeer von herausragender internationaler Bedeutung für mindestens 52 geografisch getrennte Populationen von 41 ziehenden Wat- und Wasservogelarten des ostatlantischen Zugwegs, deren Brutgebiete sich bis nach Nord-Sibirien und Nordost-Kanada erstrecken. Für 44 Populationen von 34 Arten stellt das Wattenmeer einen unverzichtbaren und häufig den wichtigsten Trittstein während des Zuges dar oder ist das Hauptüberwinterungs- und Mausergebiet.

Sowohl die Quantität als auch die Qualität der Informationen und Daten über Wat- und Wasservögel im internationalen Wattenmeer hat in den vergangenen Jahrzehnten deutlich zugenommen. Das laufende gemeinsame Monitoring-Programm („Joint Monitoring Program of Migratory Birds – JMMB"), welches im Rahmen des „Trilateral Monitoring and Assessment Program – TMAP" durchgeführt wird, umfasst jährlich zwei bis drei internationale Synchronzählungen sowie Springtiden-Zählungen, die etwa alle 15 Tage in zahlreichen ausgewählten Gebieten durchgeführt werden. Zum ersten Mal wurden nun die Bestandstrends der wichtigsten Arten berechnet und zwar getrennt für den Winter, die Hauptdurchzugszeiten sowie das ganze Jahr.

Summiert man die Zählergebnisse, so sind maximal über 6,1 Millionen Wat- und Wasservögel im Wattenmeer gleichzeitig anwesend; berücksichtigt man den „turnover" der Individuen der durchziehenden Arten, so suchen alljährlich wahrscheinlich 10-12 Millionen Wat- und Wasservögel das Wattenmeer auf. Neben Kormoran und Löffler kommen ca. 1,66 Millionen Gänse und Enten, 3,36 Millionen Watvögel und 0,96 Millionen Möwen vor. Die meisten Arten erreichen ihre Höchstbestände während des Herbstzuges; die Zahlen der Watvögel sind auch im Frühjahr ähnlich hoch, Gänse und Enten dagegen kommen im Winter in sehr hohen Beständen vor; nur Möwen kommen im Sommer auf hohe Zahlen. Praktisch die gesamte Population der Dunkelbäuchigen Ringelgans (*Branta b. bernicla*) sowie die gesamte westeuropäische Population des Alpenstrandläufers (*Calidris alpina*) nutzt das Wattenmeer während mehrerer Jahresabschnitte. Weitere sieben Arten sind mit mehr als 50% und weitere 14 Arten mit mehr als 10% ihrer geografischen Population im Wattenmeer zur selben Zeit anwesend. Hohe Bestände der Brandgans (*Tadorna tadorna*) sowie der Eiderente (*Somateria mollissima*) nutzen das Wattenmeer einschließlich der Küstenzone und der angrenzenden Nordsee zur Mauser bzw. zur Mauser und Überwinterung.

Die Trends im Winter basieren auf den internationalen Synchronzählungen im Januar. Diese Zählungen eignen sich auch für internationale Vergleiche und Populationsgrößenabschätzungen der jeweiligen geografischen Populationen. Im Januar sind 25 Arten mit Maximalzahlen von über 1.000 Individuen im Wattenmeer anwesend. Die Arten überwintern dort mit unterschiedlichen Anteilen ihrer Populationen, wobei bei den meisten das Wetter im jeweiligen Winter ausschlaggebend ist für die Bestandsgröße im Winter: sehr kalte Winter führen zu ausgeprägter Winterflucht in südlichere Gebiete und zu einer erhöhten Wintersterblichkeit. Zwischen 1980 und 2000 hat die Anzahl der milden Winter zugenommen, entsprechend haben die Zahlen der im Wattenmeer überwinternden Wat- und Wasservogelarten ebenfalls zugenommen. Angesichts der Konsequenzen des Klimawandels (häufigere milde Winter) und der damit einhergehenden Veränderung der Nahrungsressourcen ist es denkbar, dass sich zukünftig Überwinterungszahlen, lokale Trends und Verbreitungsmuster einiger Arten sowohl im Wattenmeer als auch auf dem gesamten Zugweg ändern.

Während der Hauptdurchzugszeiten im Herbst und Frühjahr, wenn das Wattenmeer vor allem eine „Tankstelle" zum Auffüllen der Energiereserven der Vögel auf dem Zuge darstellt, ist der Einfluss des Wetters weniger ausschlaggebend als im Winter, wenn die Arten sich „entscheiden" können, das Gebiet zu verlassen oder zu bleiben. Es werden die Gesamttrends angegeben, die die Bestandsentwicklung während der jeweiligen Zugperioden repräsentieren. Von den 34 Arten, für die das Wattenmeer einen bedeutenden Trittstein während des Zuges darstellt, zeigen 15 Arten (44%) signifikante Abnahmen und 7 Arten (21%) nicht signifikante Abnahmen; 3 Arten (9%) zeigen signifikante Zunahmen, 1 Art (3%) eine nicht signifikante Zunahme; bei 8 Arten (23%) fluktuieren die Zahlen so stark, dass kein Trend angegeben werden kann.

Die Gründe für die beobachteten negativen Populationstrends sind im Detail nicht für alle Arten bekannt und können auch nicht allein durch ein Monitoring bestimmt werden. Zumindest für die Dunkelbäuchige Ringelgans besteht ein klarer Zusammenhang mit schlechten Bruterfolgen in den arktischen Brutgebieten. Für einige überwiegend Muscheln fressende Arten (Eiderente, Austernfischer *Haematopus ostralegus*, aber wahrscheinlich auch Knutt *Calidris canutus* und Silbermöwe *Larus argentatus*) gibt es Hinweise, dass sich die Nahrungsverfügbarkeit in den letzten Jahrzehnten verschlechtert hat. Die Ursache dafür ist wahrscheinlich in einer Kombination von Gründen, die sowohl in der Fischerei als auch im Klima (in diesem Fall das Ausbleiben kalter Winter) liegen, zu suchen. Viele der anderen Arten mit negativen Trends nutzen das Wattenmeer mit mehr als 50% ihrer biogeografischen Population und sind zudem Langstreckenzieher. Zu deren Zugstrategie ist ein schnelles Auffüllen der Fett- und Energievorräte auf dem Zug in die Brut- oder Überwinterungsgebiete unverzichtbar. Daher hat das Wattenmeer für diese Arten eine elementare Bedeutung als große und unerschöpfliche Nahrungsquelle. Da für die meisten dieser Arten die negativen Trends in anderen Gebieten Europas nicht bestätigt werden, ist anzunehmen, dass die Gründe für die Abnahmen im Wattenmeer selbst zu suchen sind. Möglicherweise existieren auch regionale Unterschiede; so sind einige Abnahmen hauptsächlich im deutschen Wattenmeer zu finden. Um die festgestellten negativen Trends zu verstehen und umzukehren, ist zusätzliche ökologische Forschung erforderlich. Im Vergleich zu den zahlreichen abnehmenden Arten zeigen nur wenige Arten positive Gesamttrends. Dies sind Kormoran (*Phalocrocorax carbo sinensis*), Löffler (*Platalea leucorodia*) und Weißwangengans (*Branta leucopsis*), alles Arten, die während des letzten Jahrzehnts Zunahmen ihrer biogeografischen Zugwegpopulationen zu verzeichnen hatten.

Wir sind in der Lage, für die Gruppe der ziehenden Wat- und Wasservogelarten im internationalen Wattenmeer belastbare Ergebnisse zum Populationsstatus zu berechnen und können damit die Verpflichtungen erfüllen, die sich aus den europäischen Richtlinien (EG-Vogelschutzrichtlinie, Flora-Fauna-Habitat-Richtlinie, Wasserrahmenrichtlinie) ergeben. Durch die Zusammenarbeit zwischen den drei Wattenmeerstaaten – ermöglicht durch JMMB – ist es gelungen, die Daten des internationalen Wattenmeers zusammen zu stellen und Gesamtzahlen und Trends zu berechnen. Es hat sich gezeigt, dass die angewendeten Methoden zur Trendberechnung zuverlässige Ergebnisse erbringen; dessen ungeachtet steigern längere Datenreihen die Genauigkeit dieser Trendergebnisse deutlich und auch die Methoden der Trendberechnung selbst können noch weiter verbessert werden. Um den günstigen Erhaltungszustand des internationalen Wattenmeeres beschreiben bzw. anstreben zu können, müssen die Monitoring-Programme sicherstellen, dass Datenaustausch, Vergleiche und Kausalanalysen möglich sind und angewendet werden und auch andere Organismen-Gruppen und ökologische Parameter einbezogen werden.

Samenvatting

De Waddenzee is met zijn 4500 km^2 aan getijdengebied met aangrenzende kwelders en polders langs de Noordzeekust van Nederland, Duitsland en Denemarken, één van 's werelds belangrijkste wetlands voor trekkende watervogels, en het verreweg belangrijkste gebied voor pleisterende, ruiende en overwinterende watervogels langs de Oost-Atlantische vliegroute. Volgens de 1%-normen van de Ramsar-conventie is de Waddenzee internationaal van buitengewoon belang voor tenminste 52 populaties van 41 trekkende watervogelsoorten die van de Oost-Atlantische route gebruik maken en waarvan het herkomstgebied tot in noordelijk Siberië en Noordoost-Canada reikt. Bij 44 populaties van 34 soorten zijn de aantallen dermate hoog dat de Waddenzee kan worden beschouwd als een onmisbare (en vaak de belangrijkste) halteplaats tijdens de trek dan wel het belangrijkste overwinterings- of ruigebied.

In de afgelopen decennia is de hoeveelheid en kwaliteit van watervogeldata sterk toegenomen. Het huidige 'Joint Monitoring of Migratory Birds' (JMMB) programma, dat wordt uitgevoerd in het kader van het 'Trilateral Monitoring and Assessment Program' (TMAP), bestaat uit 2-3 vlakdekkende internationale simultaantellingen per jaar en twee hoogwatertellingen per maand in steekproefgebieden. Voor de eerste keer kunnen nu trends worden berekend van algemene soorten, uitgesplitst naar de winter, de belangrijkste trekperiode en het gehele jaar.

Alles optellend zijn er maximaal 6,1 miljoen vogels aanwezig in de Waddenzee; rekening houdend met de doorstroming kan het om 10-12 miljoen vogels per jaar gaan. Aalscholver en Lepelaar buiten beschouwing latend gaat het om 1,66 miljoen eenden en ganzen, 3,36 miljoen steltlopers en 0,96 miljoen meeuwen. De meeste soorten zijn het talrijkst tijdens de herfsttrek; de steltloperaantallen zijn dan vrijwel even hoog als in de lente, terwijl eenden en ganzen in groten getale overwinteren; alleen meeuwen zijn ook in de zomer talrijk. Bijna de gehele populatie Rotganzen (Zwartbuikrotganzen) en de volledige West-Europese populatie Bonte Strandlopers gebruikt de Waddenzee tijdens verschillende perioden binnen de jaarcyclus. Voorts is van zeven soorten tenminste 50% en van 14 andere soorten tenminste 10% van de flyway-populatie aanwezig. De aan de Noordzee grenzende delen van de Waddenzee vormen de ruiplaats van grote aantallen Bergeenden en de rui- en overwinteringsplaats van vele Eiders.

De wintertrends zijn gebaseerd op de internationale simultaantellingen in januari en worden ook gebruikt bij internationale vergelijkingen met betrekking tot relevante flyway-populaties. In januari zijn van 25 soorten maxima van tenminste 1000 ex. vastgesteld, in variabele aandelen van de totale winterpopulatie. Bij de meeste soorten is het winterweer een belangrijke factor: koude winters bewerkstelligen zuidwaartse verplaatsingen en soms ook verhoogde sterfte. In de periode 1980-2000 is het aantal zachte winters toegenomen, wat geleid heeft tot toegenomen aantallen overwinterende watervogels in de Waddenzee. Met het oog op de klimaatverandering (tendens naar meer zachte winters) en de daarmee gepaard gaande veranderingen in voedselvoorraden kunnen de overwinterende aantallen, lokale trends en verspreiding in de toekomst veranderen, zowel binnen de Waddenzee als op flyway-niveau.

Tijdens de trek in najaar en voorjaar spelen weersinvloeden een minder grote rol dan in de winter, wanneer soorten moeten besluiten of ze al dan niet in het gebied blijven. In dit rapport zijn de resultaten van alle belangrijke maanden binnen de jaarcyclus geïntegreerd tot een seizoenssom die voor de trendanalyses zijn gebruikt. Van de 34 soorten waarvoor de Waddenzee een belangrijke halteplaats tijdens de trek is, vertonen er 15 (44%) een significante afname, 7 (21%) een niet-significante afname, 3 (9%) een significante toename, 1 (3%) een niet-significante toename en 8 (23%) fluctuerende aantallen.

De oorzaken van de vastgestelde populatieafnames zijn niet bij alle soorten in detail bekend, en kunnen niet met monitoring alleen worden ontraadseld. Bij (in ieder geval) de Rotgans bestaat een duidelijk verband met ongunstige broedseizoenen. Bij verschillende schelpdiereters (o.a. Eider, Scholekster, wellicht ook Kanoet en Zilvermeeuw) zijn er aanwijzingen dat de beschikbaarheid van voedsel in de afgelopen decennia is verslechterd, vermoedelijk veroorzaakt door visserij en weersomstandigheden (in dit geval door het ontbreken van koude winters). Bij veel andere afnemende soorten gaat het om soorten waarvan meer dan 50% van de totale flyway-populatie van de Waddenzee gebruik maakt om op te vetten op weg naar verder gelegen bestemmingen; voor deze soorten is de Waddenzee van fundamenteel belang als voedselgebied. Omdat de afname van deze soorten elders in Europa geen parallel kent, wordt verondersteld dat de situatie in de Waddenzee zelf in het geding is; er kunnen echter regionale effecten meespelen, zoals wordt aangetoond door enkele afnames die alleen in Duitse Waddenzee zijn vastgesteld. Om de negatieve trends te kunnen verklaren is meer ecologisch onderzoek nodig. Relatief weinig soorten vertonen een opwaartse trend. Het gaat om Aalscholver, Lepelaar en Brandgans, soorten waarvan de flyway-populaties in het afgelopen decennium gestegen zijn.

We zijn inmiddels in staat om betrouwbare cijfers te produceren over de populatiestatus van trekkende watervogelsoorten in de internationale Waddenzee en kunnen daarmee onze verplichtingen nakomen zoals afgesproken in verschillende besluiten (Vogelrichtlijn, Habitatrichtlijn, Kaderrichtlijn Water). Door samenwerking tussen de drie Waddenzeelanden, mogelijk gemaakt door de JMMB, kunnen data over aantallen en trends in de internationale Waddenzee worden verzameld en geanalyseerd. De methoden van trendanalyse blijken betrouwbare resultaten te produceren; een langere dataserie zou echter de nauwkeurigheid van de trenduitspraken kunnen verhogen en de methoden om trends te bepalen kunnen nog steeds worden verfijnd. Monitoringprogramma's moeten het mogelijk maken om data uit te wisselen, vergelijkingen te trekken en causale analyses uit te voeren en hier tevens andere groepen van organismen en ecologische parameters bij te betrekken, dit alles om bescherming van de internationale Waddenzee gestalte te geven.

1. Introduction

The Wadden Sea is of outstanding international importance as a staging, moulting and wintering area for at least 52 populations of 41 migratory waterbird species that use the East Atlantic flyway and originate from breeding populations as far away as northern Siberia or Northeast Canada (Meltofte *et al.*, 1994). Numbers of 44 populations of 34 species are so high that the Wadden Sea can be considered as their indispensable and often main stepping stone during migration, or as their primary wintering or moulting habitat.

In recent decades, the amount and quality of migratory waterbird data has increased considerably. As part of the International Waterbird Census of Wetlands International, surveys formerly mainly focused on wintering numbers and distribution (Meltofte *et al.*, 1994). The current JMMB-monitoring program, carried out in the framework of TMAP, consists of 2-3 internationally synchronous (complete) counts each year and bi-monthly counts during spring tide at numerous sample sites (Rösner, 1993). All these counts are carried out during high tide, when most birds congregate at high tide roosts within reach of observers (see Koffijberg *et al.*, 2003). These surveys allow assessments of numbers, distribution, phenology and trends; several national reports have been published (van Roomen *et al.* 2004, Blew *et al.*, in prep., Laursen and Frikke, in prep.). Especially knowledge of trends has much improved over the past years since not only wintering numbers (which are often small and fluctuate according to weather) but also the more important migration periods can be fully taken into account now. Therefore, for the first time, trends for the most important species during the peak migration periods as well as trends for the entire year can now be calculated for the entire Wadden Sea.

This report gives the latest review of migratory bird numbers in 1980-2000 and provides information on trends during this time period. Maximum bird numbers given here are "estimated numbers" which take missing counts into account by calculating estimates for areas which were not covered during a count. Trends during January and the migration periods are calculated and assessed in light of potential influencing factors. Emphasis will also be given to the trilaterally agreed counting scheme in the Wadden Sea regions as well as to the methods of data exchange and trend calculation.

2. Data and Methods

2.1 Implementation of the JMMB Program

Based on the process and discussions during data compilation for the report by Meltofte *et al*. (1994), the "Joint Monitoring of Migratory Birds in the Wadden Sea (JMMB)" was started in 1992. This group includes SOVON Vogelonderzoek Nederland in The Netherlands, the Staatliche Vogelschutzwarte at the Niedersächsisches Landesamt für Ökologie (NLÖ) and the Nationalparkverwaltung Niedersächsisches Wattenmeer in Niedersachsen, the Schutzstation Wattenmeer" (formerly the WWF-Projektbüro Wattenmeer) and the Landesamt für den Nationalpark Schleswig-Holsteinisches Wattenmeer in Schleswig-Holstein and the National Environmental Research Institute (NERI) in Denmark, and operates within the framework of the Trilateral Monitoring and Assessment Program (TMAP). The Common Wadden Sea Secretariat (CWSS) in Wilhelmshaven acts as the secretariat for the group.

The JMMB installed a Joint Monitoring Project on Migratory Birds in the Wadden Sea (Rösner, 1993). The objectives of this program are (Rösner *et al*., 1994):

- to monitor changes in distribution and numbers of the populations of waterbirds within the Wadden Sea;
- to estimate total population sizes of bird species present in the Wadden Sea at any time;
- to reach proper estimates of the total numbers of birds using the Wadden Sea during a year
- to supply data for the estimation of population sizes of species using the East Atlantic Flyway;
- to collect additional information which help to explain the patterns found.

A standardized set of migratory bird counts was agreed to supply the necessary amount and quality of data for meeting the objectives. The counting program consisted of:

- Yearly midwinter counts: Internationally coordinated synchronous counts of waterbirds in the entire Wadden Sea during one weekend. These counts continue the international counts carried out since 1980 and are also part of the worldwide survey of waterbirds as organized, compiled and analyzed by Wetlands International.
- Yearly additional coordinated synchronous counts during one selected month per year. This data serves to supply additional data during times of the year other than January and thus during different migration periods. The counts should also – together with the January counts - help to calibrate the results from the spring tide counting sites.
- Spring tide counts in selected sites of the Wadden Sea. These counts aim to monitor trends of waterbird species using high-tide roosts. Each country selected representative sites for these spring tide counts.
- Complete counts of additional target species during their peak migration period in the Wadden Sea. On the trilateral level, these are Goose-counts in November, March and May and aerial counts of Common Eider in January and Common Shelduck in August.

This program has been carried out by all Wadden Sea countries since 1992; however, different national focuses lead to varying coverage for some of the topics.

2.2 Area and site selection

The selection of the area considered for this report is the Wadden Sea Area (Cooperation Area). This is, in general terms, the area seaward of the main dike (or, where the main dike is absent, the spring-high-tide-water line, and in the rivers, the brackish-water limit) up to 3 nautical miles from the baseline or the offshore boundaries of the Conservation Area (Essink *et al.*, 2005). In Denmark, birds occurring in marsh land areas behind the sea walls are included in the counts except the distal parts of both the Varde Å valley and the Ribe Marsh. In Schleswig-Holstein, the recently embanked areas are also included either fully or with their wet parts only; waterbirds which were occasionally roosting in inland areas immediately adjacent to the dike are included in the numbers of the respective counting unit outside the dike. At the mainland of Friesland and Groningen, The Netherlands, a strip of inland counting units bordering the sea barrier, and in Noord-Holland the former island Wieringen (inland counting units) are included in the study area. The polders on the islands are also included in the counts. Based on these selections, a total of 559 different migratory bird counting units exist in the Wadden Sea (Table 2.1, Figure 2.1, Annex 1).

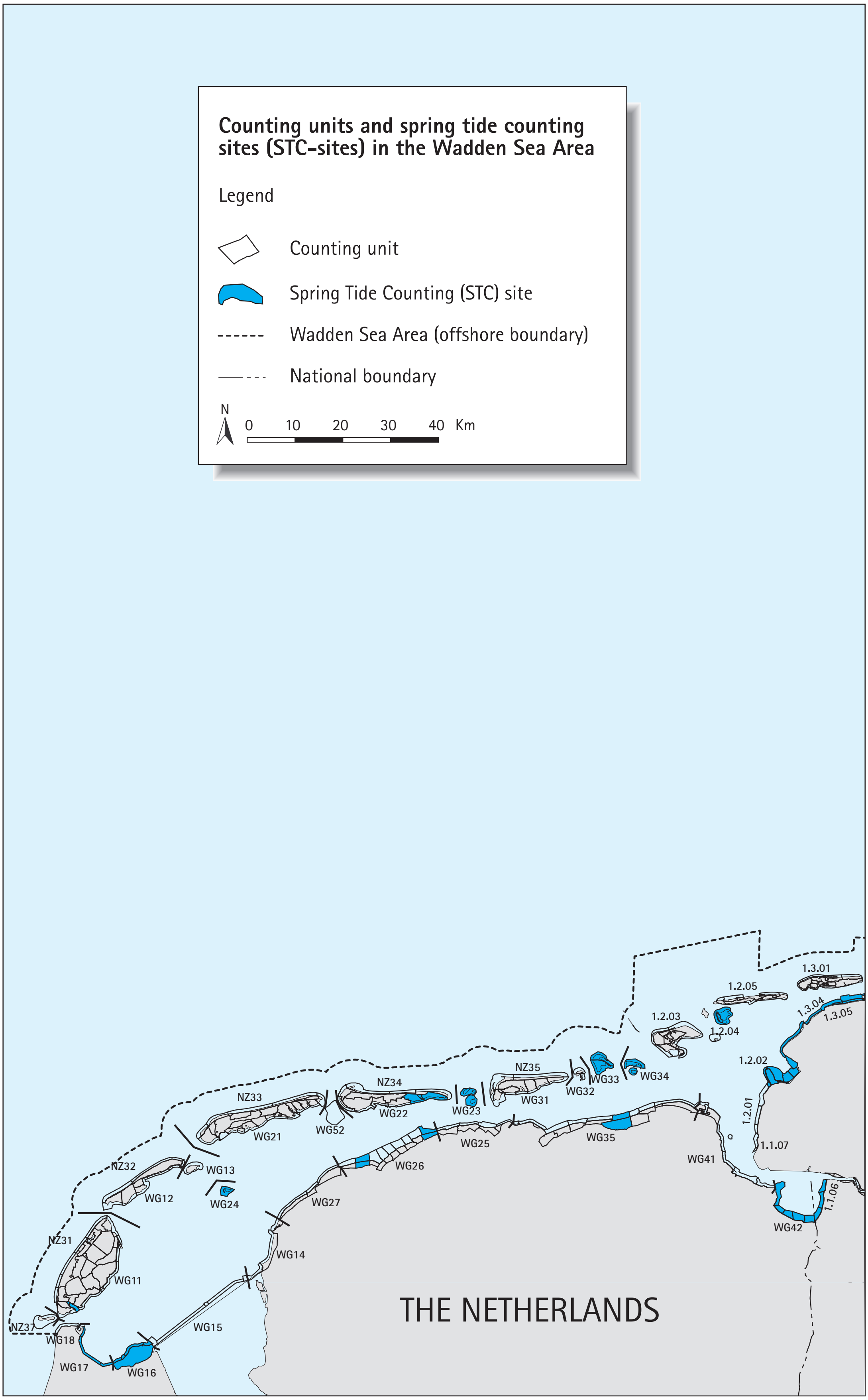
The Wadden Sea Area, delimited seawards by the three nautical mile offshore line, covers some 14,700 km² (Essink *et al.*, 2005). However, more relevant for the migratory bird counts is the area of inter-tidal flats, because these are utilized for feeding. The total area of the inter-tidal flats, measured from the edge of the vegetation (or mean high water line in case of sandbanks or sands) to the mean low water line, measures 4,534 km². Each country selected a set of spring tide counting sites, each consisting of one to twelve counting units. Most countries use some kind of hierarchical system to enable data processing at aggregated levels. For this report, the original data, available at the smallest level has been used. Data has not been grouped for data processing or presentation.

Table 2.1: Counting units per country.

Country	Area of intertidal flats [km²] *	Number of counting units	Number of spring tide counting sites	Number of spring tide counting units	Proportion of spring tide counting units to total counting units [%]
Denmark	396	91	5	31	34,1
Schleswig-Holstein	1,402	139	24	33	23,7
Lower Saxony	1,447	148	10	51	34,5
The Netherlands	1,289	181	14	32	17,7
Wadden Sea	**4,534**	**559**	**53**	**147**	**26,3**

* area of intertidal flats (from Meltofte *et al.*, 1994)

Figure 2.1: Map of counting units and spring tide counting sites (STC-sites) in the Wadden Sea Area. The national site codes respectively STC-sites correspond with Annex 1.




DENMARK
DK01
DK02
DK03
DK04
DK05
IS2A
IS61
IS3
IS46
IS42
IS41
IS1
IS43
IS44
IS45
VN1
FN1
VN2
IF1
IF411
IA61
IA4
IF2
IF6
IF5
IF412
FN2
IA31
IA1
IF3
IF42
IH12
IH2
VN3
FN3
FN4
IH4
IH1
IA32
IA62
IH111
IH3
VN4
VN5
IA2
IH6
VN6
SN1
IP1
IH5
FN6
IH7
IP2B
SN2
IP4
VN9
IP2A
VN8
VN7
IH8
IH9
VE1
FE1
SN3
FE2
VE2
VE3
FE3
EE4
VE4
VE51
FE5
FE6/7
VE52
EE1
EE3
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VE53
VE54
FD4
VD11
FD3
Schleswig-
Holstein
SD1
VD12
VD21
FD1
VD22
VD3
IT
FD7
FD2
VD41
FD8
VD42
VD51
VD52
1.7.03
1.7.02
1.8.03
1.8.01
1.8.06
1.4.01
1.4.02
1.3.03
1.4.03
1.7.01
1.3.01
1.3.02
1.4.05
1.2.05
1.4.04
1.3.06
1.3.07
1.6.01
1.7.04
1.3.04
1.3.05
1.2.03
1.2.04
1.4.07
1.4.09
1.6.02
1.2.02
1.5.01
1.2.01
1.5.02
1.9.01
1.1.07
1.9.02
WG41
1.1.03
1.1.06
1.9.03
WG42
Niedersachsen
GERMANY

2.3 Species selection

The waterbird species covered in this report are those which either in their entire population or part of their population use the Wadden Sea as a staging, roosting, feeding or wintering area during one part of its yearly cycle (Table 2.2). Species which only occur in low numbers or species which cannot be counted with some representativity have been excluded from the analyses (for a more detailed explanation see Rösner *et al.*, 1994).

2.4 Fieldwork

Counts of waterbirds in the Wadden Sea are carried out during daytime and high tide, when most birds congregate at communal roosts along the shoreline and at islands and remaining sand flats (Koffijberg *et al.*, 2003); sometimes, birds are also counted further inland, e.g. in polders (see Chapter 3.1). Counting dates are chosen around spring tide, and usually fieldwork is concentrated during a narrow time window around a chosen counting date, preferably avoiding adverse observation conditions such as fog and heavy rain. Observers mostly operate from dykes or dunes, using high magnifyication (20-60x) telescopes to determine species and numbers. In larger salt marshes, trips to the shoreline are also made in order to obtain a better view of the roosting flocks. Small uninhabited islands and sands are counted from boats or are reached by foot during low tide; many of those are only counted from May to October.

Table 2.2: List of species covered in the report.

Euring-Code	English species name	Scientific species name	Danish species name	German species name	Dutch species name
00720	Great Cormorant	*Phalacrocorax carbo*	Skarv	Kormoran	Aalscholver
01440	Eurasian Spoonbill	*Platalea leucorodia*	Skestork	Löffler	Lepelaar
01670	Barnacle Goose	*Branta leucopsis*	Bramgås	Weißwangengans	Brandgans
01680	Dark-bellied Brent Goose	*Branta bernicla bernicla*	Mørkbuget Knortegås	Dunkelbäuchige Ringelgans	Rotgans
01730	Common Shelduck	*Tadorna tadorna*	Gravand	Brandgans	Bergeend
01790	Eurasian Wigeon	*Anas penelope*	Pibeand	Pfeifente	Smient
01840	Common Teal	*Anas crecca*	Krikand	Krickente	Wintertaling
01860	Mallard	*Anas platyrhynchos*	Gråand	Stockente	Wilde Eend
01890	Northern Pintail	*Anas acuta*	Spidsand	Spießente	Pijlstaart
01940	Northern Shoveler	*Anas clypeata*	Skeand	Löffelente	Slobeend
02060	Common Eider	*Somateria mollissima*	Ederfugl	Eiderente	Eidereend
04500	Eurasian Oystercatcher	*Haematopus ostralegus*	Strandskade	Austernfischer	Scholekster
04560	Pied Avocet	*Recurvirostra avosetta*	Klyde	Säbelschnäbler	Kluut
04700	Great Ringed Plover	*Charadrius hiaticula*	Stor Prästekrave	Sandregenpfeifer	Bontbekplevier
04770	Kentish Plover	*Charadrius alexandrinus*	Hvidbrystet Prästekrave	Seeregenpfeifer	Strandplevier
04850	Eurasian Golden Plover	*Pluvialis apricaria*	Hjejle	Goldregenpfeifer	Goudplevier
04860	Grey Plover	*Pluvialis squatarola*	Strandhjejle	Kiebitzregenpfeifer	Zilverplevier
04930	Northern Lapwing	*Vanellus vanellus*	Vibe	Kiebitz	Kievit
04960	Red Knot	*Calidris canutus*	Islandsk Ryle	Knutt	Kanoetstrandloper
04970	Sanderling	*Calidris alba*	Sandløber	Sanderling	Drieteenstrandloper
05090	Curlew Sandpiper	*Calidris ferruginea*	Krumnäbbet Ryle	Sichelstrandläufer	Krombekstrandloper
05120	Dunlin	*Calidris alpina*	Almindelik Ryle	Alpenstrandläufer	Bonte Strandloper
05170	Ruff	*Philomachus pugnax*	Brushane	Kampfläufer	Kemphaan
05340	Bar-tailed Godwit	*Limosa lapponica*	Lille Kobbersneppe	Pfuhlschnepfe	Rosse Grutto
05380	Whimbrel	*Numenius phaeopus*	Lille Regnspove	Regenbrachvogel	Regenwulp
05410	Eurasian Curlew	*Numenius arquata*	Stor Regnspove	Großer Brachvogel	Wulp
05450	Spotted Redshank	*Tringa erythropus*	Sortklire	Dunkler Wasserläufer	Zwarte Ruiter
05460	Common Redshank	*Tringa totanus*	Rødben	Rotschenkel	Tureluur
05480	Common Greenshank	*Tringa nebularia*	Hvidklire	Grünschenkel	Groenpootruiter
05610	Ruddy Turnstone	*Arenaria interpres*	Stenvender	Steinwälzer	Steenloper
05820	Common Black-headed Gull	*Larus ridibundus*	Hättemåge	Lachmöwe	Kokmeeuw
05900	Common Gull	*Larus canus*	Stormmåge	Sturmmöwe	Stormmeeuw
05920	Herring Gull	*Larus argentatus*	Sølvmåge	Silbermöwe	Zilvermeeuw
06000	Great Black-backed Gull	*Larus marinus*	Svartbag	Mantelmöwe	Grote Mantelmeeuw

Data is collected within small-scale counting units which can be covered by a single observer (or team of observers) during one high tide. In Denmark, part of the data presented here refers to aerial surveys. For this purpose, a standardized flight route is used covering all parts of the Danish Wadden Sea, including open water (*e.g.* Laursen *et al.*, 1997). Aerial counts of Common Eider and Common Shelduck are carried out in the entire Wadden Sea.

Large-scale waterbird counts as carried out in the entire Wadden Sea, are subject to various errors, as observers often have to recognize species from considerable distances and count large flocks in a short time. Experiments have revealed 5-10% counting errors for the most common and more evenly dispersed species, however, in some situations the counting errors are up to 37% (Rappoldt *et al.*, 1985); larger stochastic errors occur in less abundant species, which are often overlooked, and species which usually gather in a few large flocks (*e.g.* Knot). Although errors are inevitably present in the data we do not think that they influence the patterns described to any large extent.

2.5 Classification of winters

Numbers and trends of migratory waterbirds in January are indispensable for international work and comparisons. However, with the regard to the utilization of the Wadden Sea, winter trends are highly dependent on the actual weather.

Winter strength can be categorized. Using average daily temperature data and the number of "ice days" (days with a maximum temperature below 0° C), Fleet and Reineking (2001) categorized the winters 1991/1992 to 1999/2000 (Table 2.3, Figure 2.2, Figure 2.3).

Year	Classification	Year	Classification
1991/1992	normal	1992/1993	normal
1993/1994	normal	1994/1995	normal
1995/1996	extremely cold	1996/1997	very cold
1997/1998	normal	1998/1999	normal
1999/2000	mild		

Table 2.3: Winter categories 1991/1992 to 1999/2000 (adapted from Fleet & Reineking, 2001).

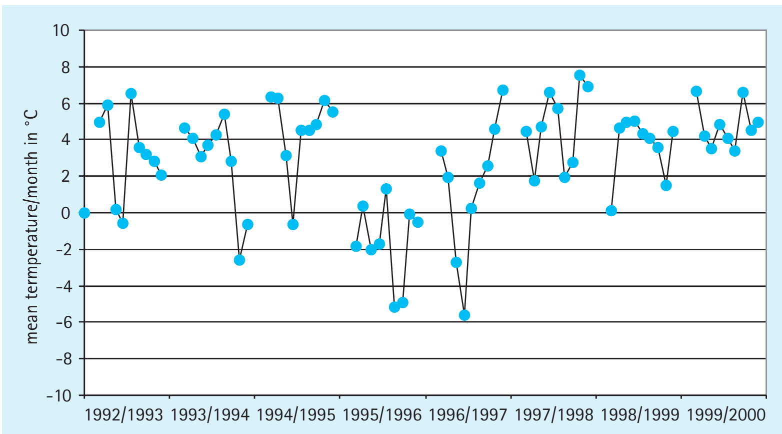


Figure 2.2: Average temperature on the island of Norderney (Germany) per decade during the months December, January and February 1992/1993-1999/2000 (data source: TMAP, data provided by DWD).

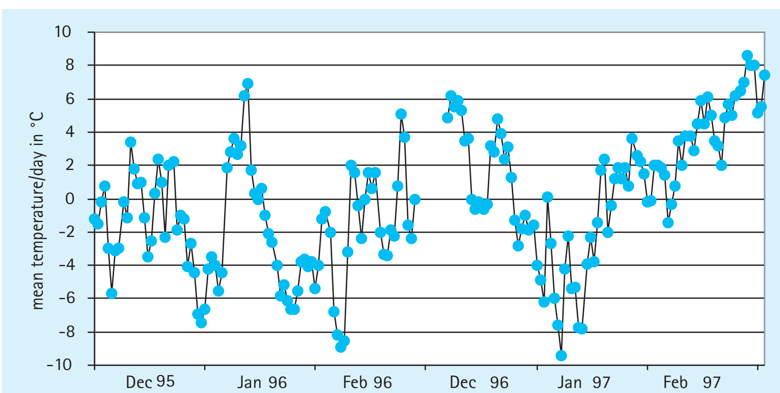


Figure 2.3: Daily average temperatures on the island of Norderney (Germany) during the months December, January and February 1995/1996 and 1996/1997 (data source: TMAP, data provided by DWD).

For birds, winter movements are initiated by very low temperatures (*e.g.* Ridgill and Fox, 1990). Both winters, 1995/1996 and 1996/1997, are classified as cold. Yet, the cold spells in both winters took place during different periods. Both winters started with very low temperatures during the last decade of December. In winter 1995/1996, the first frost period of 14 days forced many birds to leave the Wadden Sea, but during the following period of 11 days with milder temperatures many of the remaining birds continued to stay over winter or even returned to the Wadden Sea area. The next period of 24 days with heavy frost started on 17 January 1996, but did not immediately affect the birds, so that during the synchronous count on 20 January 1996, many birds were still present. In winter 1996/97, the frost period starting during the last decade of December lasted for 24 days until 13 January 1997. During that period the Wadden Sea turned into a frozen landscape and most birds left the region. Since the synchronous count took place during the last days of the frost period (9 January), many fewer birds were recorded than in the winter before.

This demonstrates that it is not enough to record the parameters "ice days" or "lowest average temperature" during one winter to draw conclusions about the birds' behavior, but the chronological sequence of the cold spells must also be taken into account.

2.6 Data exchange, data processing and trend analyses

Migratory bird data in the Wadden Sea countries has grown both in quality and quantity during recent decades. This offers the potential for better and more detailed analysis of numbers, trends and distribution. At the same time, the effort to exchange data and to agree on certain analysis methods has also increased. In this section of the method description, more details will be provided with regard to data exchange, processing and analysis for this report.

2.6.1 Data exchange

After some initial discussions and circulation of a questionnaire amongst JMMB, a simple "data exchange format" has been agreed in order to enable all parties to easily convert their own data (Table 2.4). Separation of the date into the fields year, month and day was chosen, because date formats in different programs are not always compatible. Data is provided at the counting unit level (see Glossary Annex 3). It has been decided to deliver practically all available data according to species, counting unit and time selection. This way, the extraction of the "best" data as well as the statistical analysis can be carried out at one central place, thus avoiding duplicated work at several places. All data has been converted into a dBASE format (dBASE V for DOS) and all bird counting data has been compiled into one database table. An additional database table had to be kept for the Danish spring tide counting data, since it was not possible to combine the Danish spring tide counting data and the other Danish counts.

In addition to the bird counting data, metadata per country has been put into separate tables as there are:

- lists of counting unit codes with additional information about site hierarchy, names of counting units, spring tide count sites;
- counting date lists.

2.6.2 TRIM – its potential and limitations

The TRIM program (Trends and Indices for Monitoring Data, version 3.1) has been used to impute missing values and to analyze trends (Pannekoek and van Strien, 2001). The options which have been considered to analyze trends will not be discussed in detail here. However, the process in short is as follows:

Table 2.4: Data exchange format.

Field name	Field type	Range	Comments
code of counting unit	character		provide maps, hierarchical order etc.
year	integer or character	1992-2000	
month	integer or character	01-12	
day	integer or character	01-31	
Euring	character (integer)		provide species names for special eurings, e.g. subspecies etc.
number	integer	-1 to 999,999	- if a species is present, its number is > 0; - if a species is not present, it has no dataset; - if a species is not counted, its number is -1

Missing values always existed and will exist with any large-scale counting program. Thus, two steps are necessary: 1) find a method to account for the missing values (imputing), 2) find a program to calculate trends for migratory bird data. Numerous different methods have been applied to migratory bird data, and all have advantages and disadvantages (for an overview see: ter Braak *et al.*, 1994; Kershaw *et al.*, 1998). Recently, the program UINDEX (Bell, 1995) has been used in many countries (*e.g.* Underhill and Prys-Jones, 1994). This program is able to take site and month-factors, and thus the phenology into account to calculate index values. However, it does not give statistical parameters, above all no confidence limits on the modeled values. Generalized Linear Modelling (*e.g.* Goedhardt and ter Braak, 1998) or Generalized Additive Models (GAM) (*e.g.* Austin *et al.*, 2003) require considerable capacities both in statistical knowledge and computer resources. As a compromise, the program Trends and Indices for Monitoring Data (TRIM) (Pannekoek and van Strien, 2001) has now been accepted by many national and international colleagues and institutes working with both migratory and breeding bird data (*e.g.* Delany *et al.*, 1999; van Strien *et al.*, 2001, Wetlands International, 2002, Germany: Schwarz and Flade, 2000; Sudfeldt *et al.*, 2000; Sudfeldt *et al.*, 2003; Wahl *et al.*, 2003; France: Deceuninck and Mahoe, 2000). TRIM integrates the imputing and the trend analyses into one process; it gives modeled values, yearly indices with standard errors and trend estimates. It is suitable for analyzing time series data and offers an interface to chose between the three model types described below. For the particular problems of waterbird count data one can take "serial correlation" or "overdispersion" into account. However, TRIM can only handle one datapoint per year (per unit and species), and thus is not able, like UINDEX, to take the phenology into account when filling in values.

Data conversion for and analysis with TRIM

TRIM requests one file for each month-species combination. Thus, for this report, considering nine months and 34 species, 306 files needed to be generated.

Site-identifiers (counting unit codes) and time-point-identifiers (years) must be numbers, the latter in a consecutive series. Thus, the original data must be converted and then re-formatted to be written to a text file. First, counting units with no data for a month-species combination must be excluded.

To be able to compare trends in the international context, the same parameters of the program have been chosen as in Wetlands International analyses and publications (*e.g.* Delany *et al.*, 1999).

At first, for each species the model 3 "time effects" was chosen. If, for a species, the model failed because of a) "in one year only zero values are present" or b) "data did not converge", the model 2 "linear trend" was chosen. For model 2, a "stepwise" selection of each year was chosen, but, for example, excluding the data-deficient year from this selection. The period 1992/1993 has – arbitrarily - been chosen as a reference for index calculations, resulting always in an index value 1 for 1992 or 1993, depending on the month chosen. In the TRIM command files the following additional settings have been used: "Serial correlation - on", "Overdispersion - on", no weights and no covariates have been defined.

TRIM produces two output files, one with the "counted and imputed numbers", and one with the "index values" including their confidence limits. For each trend calculation TRIM also produces a text file, presenting results and parameters of the calculation procedure. Here, the overall trend estimate and its standard error is given; it appears as "Overall slope (with intercept) – Multiplicative and standard error". These values are used for the classification of the trend estimates (see Chapter 2.6.5).

A dBASE program converts the TRIM output files into a format that can be read by Excel (or any other spreadsheet / graphics program).

2.6.3 Phenologies

For the phenology graphs in the heading of each species account, data from the spring tide counting sites was used. For the period 1992/1993 – 1999/2000, for each counting unit the maximum count of each half-month was chosen. The arithmetic mean of those values over the eight years resulted in one number per counting unit per half-month. Those numbers were added up to present the phenology of each species in the entire Wadden Sea area.

2.6.4 Trend analysis

Trends during January

For January counts, data from the international synchronous counting dates and an interval of +/- 8 (geese +/- 2 days) days has been extracted. Choosing these intervals is in line with previous data analyses (Meltofte *et al.*, 1994) and it is a compromise between using a small interval, minimizing the risk of double counts but losing information and dealing with less significant results, and a large interval, increasing the risk of double counts. Especially in January, adverse weather conditions may hamper counting so that that the counters choose an alternative counting date; since many volunteers count on weekends, only an interval of +/- 8 days includes weekends before or after.

Trend for January data has been calculated for the years 1992–2000. Since the two cold winters 1996 and 1997 exert a considerable influence on the trend parameters, they have been excluded for most species (except Sanderling).

Trends during other months

Trends have been calculated for selected months relevant to the respective species migration patterns. These months should ideally represent periods when the species reach maximum numbers with some regularity within the Wadden Sea, thus defining the time period when the Wadden Sea is most important for the species.

Based on the phenology graphs and expert knowledge, for each species some months have been chosen for and others months have been excluded from trend analyses. The following aspects have been taken into account:

- months with peak numbers and stable numbers have priority and are included;
- months with high numbers but strong increases or decreases (phenology) or months showing high fluctuations (as shown in the phenology figures) have a lower priority but might be included to substantiate results from the months before or after;
- months with low numbers are excluded (exception January).

For these calculations results from the international synchronous counts, the spring tide counts and additional data from national or regional counting schemes have been used. Depending on the exact international synchronous counting date within the eight year period, for the selection of the additional data (spring tide counts or other data available) a counting interval of 17 days (counting date +/- 8 days) either at the beginning, the middle or the end of a month was chosen. To also allow a trend analysis for September (no international synchronous count during 1992-2000), data from all mid-Septembers is extracted as above. Data for February, July and December (no international synchronous count 1992-2000) is also used to substantiate findings for other times of the year, however, no trend analyses have been performed for these months (see Table 2.5).

Table 2.5: Dates of all international synchronous counts 1980–2004.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	
1980	19			19					13		8		Counts available for analyses in all four regions of the Wadden Sea (Meltofte *et al.*, 1994).
1981	17		7						26				
1982	9				8			14		16			
1983	15				14				10				
1984	21		17							13			
1985	19				18								
1986	11			26									
1987	17				2						7		
1988	9				7				10				
1989	21				6					7			
1990	13				12				22				
1991	19				4	15							
1992	18												No extra counts had been agreed upon.
1993	9												
1994	15									8			One extra international synchronous count in a month other than January available for this analysis.
1995	21				6								
1996	20							17					
1997	11										15		
1998	10		14										
1999	16					12							
2000	22			8									
2001	13						21						Most recent extra international synchronous counts.
2002	12								7				
2003	18				17								
2004	10									16			

Trend category		Trend parameters	[% change over 8 or 20 years; R^2]		
		overall trends (8 years)	overall trends (20 years)	January trends (20 years)	significance level
substantial increase	++	> + 20 %		> + 40 %	if R^2 < 0,25 – n.s.
increase	+	+ 10 % - + 20 %		+ 20 % - + 40 %	if R^2 < 0,25 – n.s.
stable / fluctuating	S / F	- 10 % - + 10 %	expert guess	- 20 % - + 20 %	if R^2 < 0,25 – fluctuating
decrease	-	- 10 % - - 20 %		- 20 % - - 40 %	if R^2 < 0,25 – n.s.
substantial decrease	--	< - 20 %		< - 40 %	if R^2 < 0,25 – n.s.

Table 2.6: Trend classifications for trends not calculated with TRIM (n.s. = not significant; further explanation see text).

Trends for geese

In March and May, special international synchronous goose counts are performed. These data together with the data from the other months has been used for the analyses. For geese, the interval around the counting date has been shortened to +/- 2 days, accounting for the high mobility of these species. Otherwise, if numbers from a longer interval were included, numbers could potentially be overestimated. Naturally, compared to results from a calculation with +/- 8 day, the shortening of the interval led to more "missing counts", to lower "counted numbers", to higher "imputed numbers" and thus to less significant trend estimates, but overall results and patterns for the January counts and the goose counts in March and May did not change considerably.

Overall trends

Trend calculations with TRIM are carried out for single months as far as possible during peak migration times of each species. This might be considered as only a spotlight on that particular peak migration time and some species use the Wadden Sea during extended periods of time without showing very pronounced peaks (*e.g.* Mallard). The most suitable parameter for overall usage would be "bird days from July to June the following year". As will be discussed (Chapter 5.3), we could not calculate such a parameter.

Within this report, three additional trends are calculated:

1) Overall trend in the Wadden Sea 1992-2000:
Per species and per year (bird year), all counted and imputed values for the nine months with regular data (excluding February, July and December) have been added up. A linear regression has been performed on these bird-year sums. Slope of the regression line and the quality of the regression (expressed with the value R^2) are used to give a trend estimate for each species (Table 2.6).

2) Long-term trends 1980-2000:
Since raw data from 1980-1991 is not retrievable, a calculation of overall long-term trends was not possible.

2a) Overall trend in the Wadden Sea 1980-2000:
Long-term trends have been assessed by looking at the numbers in the most important months during both periods. These long-term trends have not been statistically tested.

2b) January trends from 1980 to 2000:
Per species, all January results between 1980 and 2000 (estimates) have been used to calculate a linear regression. Inclination of the regression line in combination with the R^2 is used to give a trend estimate for each species (Table 2.6).

2.6.5 Trend categories

In order to compare both TRIM calculated and categorical parameters with other publications and analyses, trend estimates have been categorized. In the TRIM Manual, this trend categorization is described as follows (Pannekoek and van Strien, 2001):

- *the 95% confidence interval of a trend estimate is computed by multiplying the standard error by 1.96. If this interval does not include the value 1, then the trend is statistically significant;*
- *the lower and upper limit of the confidence interval is converted into the corresponding magnitudes of change in a 20-year period, using the lower and upper limits of the interval as factors. Thus, a lower limit of 0.95 results in a magnitude of change of* $(0.95)^{19}$ *in 20 years;*
- *if the trend is significant and the magnitude of change is significantly greater than 20% in a 20-year period, then the trend was considered as a substantial decline or increase;*
- *if the trend is significant, yet the change was significantly less than 20%, the trend is classified as a non-substantial decline or increase;*
- *if the trend is significant, but not significantly different from a 20% change, the trend is classified as a decline or increase;*

- *if the trend is not significant and the confidence limits were sufficiently small that the trend is significantly less than 20% in a 20-year period, the species is classified as having a stable population;*
- *if the trend is not significant and the confidence limits are so large that the trend could be larger than 20%, the population trend is classified as "poorly known", which implies that the statistical power of the scheme for that particular species is too limited to detect a change of less than 20% in 20 years. In such cases, the scheme could still be useful to detect very large changes.*

This trend classification may be better understood by looking at Figure 2.4. The time interval covered in this report is either nine years (trend in January 1992-2000) or eight years (trends for all other months).

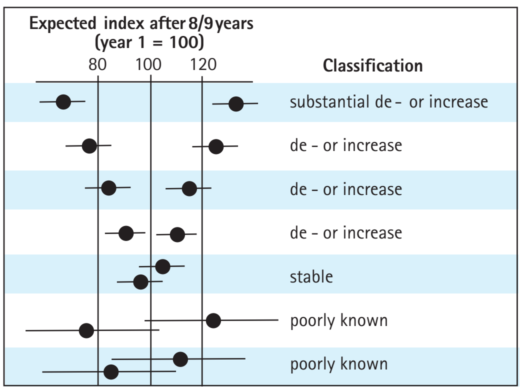


Figure 2.4: Trend categories (Index values expected after eight or nine years; horizontal bars show standard error).

For all trends not calculated with TRIM, a similar classification has been adopted (Table 2.6).

For the long-term overall trends, there are only four categories: + increasing; S stable; - decreasing, F fluctuating.

2.7 Presentation of data

2.7.1 Presentation of data in figures and tables

Phenology figures

These figures serve mainly to identify the phenology pattern in the Wadden Sea and to select months relevant for trend analyses. The phenology figures cover one bird-year from July to June in the consecutive year. 24 counts per year for the period 1992/1993-1999/2000 are used; given is the arithmetic mean per half-month over the eight year period, no scale is given for the numbers. These figures account for the phenology in the entire Wadden Sea; regional phenologies may differ considerably from this overall pattern, especially from North to South; data and figures of regional phenologies can be found elsewhere (Meltofte *et al.*, 1994; Koffijberg *et al.*, 2003).

January: Figures of Counted and imputed values for 1980-2000

These figures are presented for each species which shows average January numbers of more than 10 individuals. Imputing for the years 1980-1991 followed the method described in Meltofte *et al.* (1994), whereas for the years 1992-2000 it follows the method described within this report. It is expected, however, that the difference in the two methods has no large influence on the estimated totals and the two periods can be compared.

The lower portion of the bar represents the counted numbers, the upper portion the imputed numbers. Together they represent the estimated total for each count.

All months: Figures of counted values plus index values

Here, only the counted values are given. Instead of showing the imputed values, the index line including the confidence limit is presented on a scale which matches the height of the imputed values.

Counts for the first half of the year (February-June) are from the years 1993-2000, and from the second half (July-December) are from 1992-1999.

Maximum counted and estimated numbers per season

To avoid outliers in the calculation of maximum counted and estimated numbers, the arithmetic mean of the three highest values was calculated. Estimates in which the proportion of the imputed number exceeds 50% were excluded from this calculation. However, in the species account text, the maximum counts are given or referred to.

Tables in the Annex give the exact national counted and imputed values for all international synchronous counts (for a detailed description see Annex 2).

2.7.2 Presentation of data: rules and conventions

English species names in Table 2.2 and the headings of the species accounts follow Wetlands International (2002) (based on the *Handbook of the Birds of the World* – del Hoyo *et al.*, 1992 / 1996). In the text, the more commonly used species names are used.

Numbers are given as rounded numbers; more than 1,000 rounded to the full 100, less than 1,000 to the full 10. The tables in the Annex 2 contain the exact numbers.

The time period for which data analyses have been carried out for this report is always given as "1992-2000", even though only for January data from nine years has been compiled. For the months February to June, data from the years 1993-2000, for the months July to December, data from the years 1992-1999 has been used. Consequently, the term "previous decade" always refers to the time period covered in report of Meltofte *et al.* (1994), January 1980 to June 1991.

Throughout this report, season names are defined and used as follows:

- summer – June,
- autumn – (July) Aug to Nov,
- winter – Dec to Feb,
- spring – Mar to May.

Numbers given as "counted numbers" represent the exact counted results, rounded as mentioned above. "Estimated numbers" are the "counted numbers" plus the "imputed" proportion.

In tables, calculations and analyses, the "estimated number" is omitted whenever the "imputed" proportion exceeds 50%, and the highest "estimated number" with a proportion of less than 50% is used.

Flyway populations: Information from Wetlands International (2002) has been used to obtain data for the flyway populations staging within or migrating through the Wadden Sea area. For each species and population, the subpopulations range is given either as the breeding or the non-breeding range. If more than one flyway population occurs in the Wadden Sea area, information for each of the populations is given (Wetlands International, 2002; Stroud *et al.*, 2004). In general, the application of the Ramsar Criterion 6 - *"...a wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbirds..."* - is carried out such that the 1% threshold of the largest population is used for the assessment (Wetlands International 2002). This is true for migratory periods of spring and autumn when a separation of different populations during the counts or due to the migration behavior is not possible. For species and populations of which the winter distribution is known, the criterion is only applied to the population wintering in the Wadden Sea area. Those species / populations are: *Calidris canutus islandica, Calidris a. alpina, Limosa l. lapponica, Tringa totanus robusta, Arenaria interpres* (breeding in Greenland, NE Canada). The species *Charadrius hiaticula, Pluvialis apricaria* and *Larus argentatus* may have separate populations in winter, but all can overwinter in the Wadden Sea and thus cannot be treated separately.

Trend estimates given within the text for the period 1992-2000 are used as categories (see "Classification of trends" in Chapter 2.6, Figure 2.4 and Table 2.6); to emphasize this, all trend estimates within the text are put in quotes (*e.g.* "substantial increase"). Trend estimates of the flyway populations, given in five categories (sta = stable, dec = decreasing, inc = increasing, flu = fluctuating, exit = extinct), refer to the most recent reference. Thus the time base is not standardized, nor is there a standard given regarding the magnitude of change before a population trend can be stated as increasing or decreasing (Wetlands International, 2002).

3. Quality of Data

3.1 Coverage of main staging areas through site selection

The Wadden Sea Area – by definition – does not include inland counting units. Even though in some parts of the Wadden Sea some inland sites have been involved in the analyses for this report (see Chapter 2.2), some typical Wadden Sea species may not be adequately covered by the counts, since they fly inland during feeding times or high tide. This applies to the two goose species and is further examined by Koffijberg and Günther (2005, this volume). The gull species are also found either out on the sea or at harbors, garbage dumps and other inland areas, thus escaping counting efforts. Curlews are known to utilize inland pastures up to 15 km from the dike (Zwarts, 1996; Gloe, 1998, 1999) and thus are only partly covered. Golden Plover and Oystercatcher frequently remain inland during low tide. Precise figures for the numbers of birds staying inland are sometimes unknown (except for geese) as these areas are not frequently monitored during the high tide counts.

3.2 Counting coverage

Coverage as defined here is the parameter "counted counting units per time-unit". However, the number of counted counting units is a first approach to the coverage of an area, but does not directly define coverage. Several "unimportant" counting units might host only a few numbers of birds, thus a low counting coverage may not inflict the data quality, whereas missing one very important counting unit with many birds may have more serious implications. A parameter stating the number or proportion of present birds covered would be more appropriate, but this is currently not available.

3.2.1 Synchronous counts in January

During the nine international synchronous counts in January, an average of 382 counting units (of 559 counting units) has been counted, with a minimum coverage of 280 counting units in January 1993 and a maximum of 445 counting units in 1998 (Figure 3.1). For January 1993 and 1994, no counts from Denmark are available. Clearly, coverage has improved during the recent decade, with more than 440 counting units counted during the last three years. It must be taken into account that especially during January adverse weather conditions may hamper counting effort and some sites (outer banks, sands) are hard or impossible to reach.

3.2.2 Synchronous counts in months other than January

In each year between 1994 and 2000, one additional international synchronous count was carried out; counts exist from seven additional months. An average of 413 counting units was counted during the international synchronous counts. October 1994 is the only international synchronous counting date with no counts from Denmark (Figure 3.2).

During the months not included in international synchronous counts during 1992-2000, counts are also available, stemming either from the spring tide counts or from additional national counting schemes. However, the coverage is fairly different between the countries. Especially for Denmark, the number of monthly counts is limited to those months when aerial counts were carried out. For the months without any internationally coordinated synchronous counts 1992-2000 – February, July, September and December – as well as for the additional months entered into the analyses, an average of 213 counting units were counted per counting date (Figure 3.2).

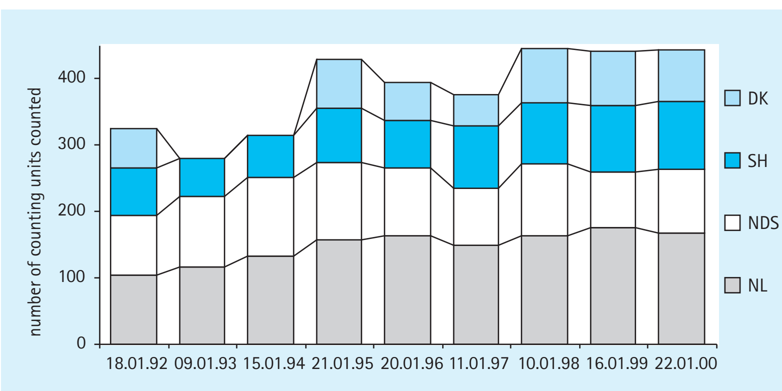


Figure 3.1: Coverage during the international synchronous counts in January; a total of 559 counting units exist.

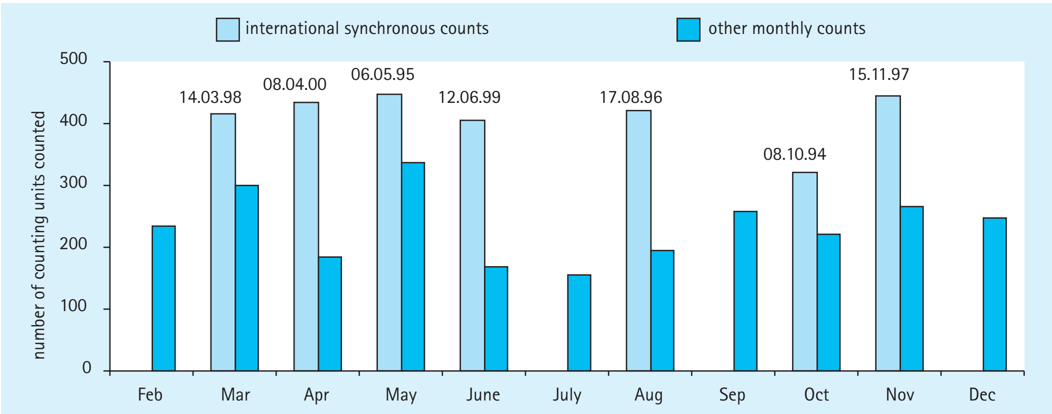


Figure 3.2: Coverage during the international synchronous counts in months other than January and additional counts from other years; a total of 559 counting units exist.

3.2.3 Spring tide counts

The spring tide counting scheme started in 1992 in almost all countries. One count per spring tide (about every 14/15 days) potentially results in 24 to 25 counts per site and year, adding up to 192-200 counts per site and year during the considered period 1992/1993-1999/2000. Best coverage has been achieved during the years 1996/1997-1998/1999 (Figure 3.3), while with regard to the months, the period from March to May has the most frequent counts. The following facts have to be taken into account:

- each country has its own selection of spring tide counting sites; this leads to different proportions of the area represented by spring tide counting sites and thus to a different representativity both for certain habitats as well as for certain species (*e.g.* Poot *et al.*, 1996; Willems *et al.*, 2001; Blew and Südbeck, pers.comm.) (see Annex 1 and Figure 2.1);
- the average number of counts per spring tide counting sites differs between the countries (Figure 3.3 and Figure 3.4);
- The Netherlands has only a few spring tide counting sites with a spring tide counting rhythm – Mokbaai, Holwerd oost, Oude Bildtpollen. Some counting units have a spring tide counting rhythm during summer, but not in winter, some started only in 1995/1996; some counting units were started already in 1970, but are counted only once a month (*e.g.* Dollard, Balgzand, Wieringen);
- in Niedersachsen, for some spring tide counting sites the summer months are less well covered;
- in Schleswig-Holstein, the spring tide counting sites are generally well covered;
- in Denmark, Margrethe-Kog started the spring tide counting program in 1993/1994, Indvingen and both Fanø areas in 1995/1996; Langli has been covered since 1992 with a large number of counts.

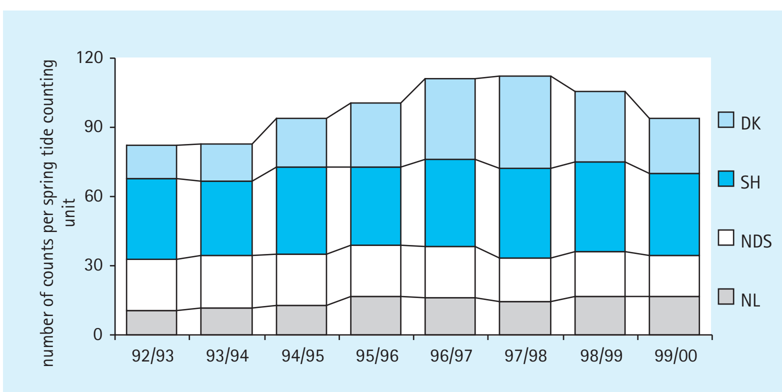
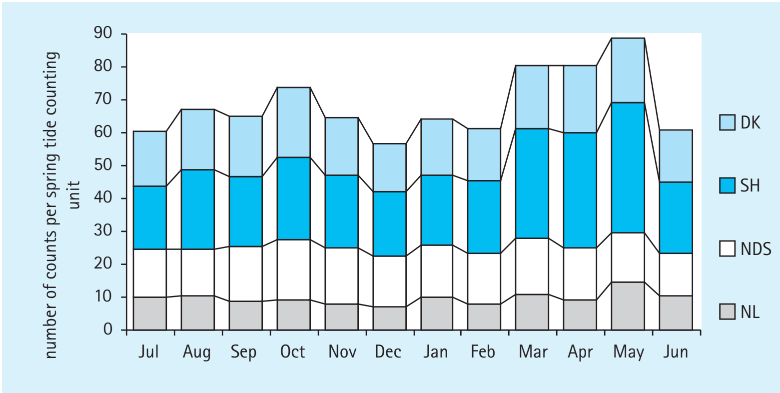


Figure 3.3: Coverage of spring tide counting sites per year 1992-2000. Given is the average number of counts per spring tide counting unit and year.

Figure 3.4: Coverage of spring tide counting sites per month 1992-2000. Given is the average number of counts per site.



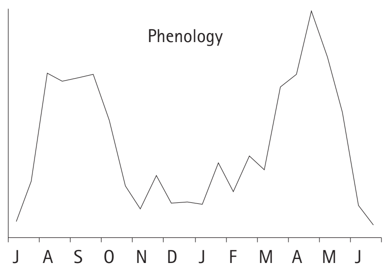
3.2.4 Special counts of target species

During 1992-2000, a total of eight goose counts were carried out between 13-20 March (focusing on Barnacle Goose) and eight goose counts between 4-10 May (focusing on Brent Goose). In the species accounts, aerial counts of moulting birds during early August in Schleswig-Holstein have been used for Shelduck and aerial counts during January and February in the entire Wadden Sea for Eider. For Sanderling, special counts have been carried out at a selection of sites during late May from 1998 on.

4. Species Accounts

Explanation for the values, tables and figures appearing in each species account – Example: Red Knot

Euring number	*Danish name*	*German name*	*Dutch name*
04960	Islandsk Ryle	Knutt	Kanoetstrandloper



Phenology
For the period 1992/1993 – 1999/2000, for each counting unit the maximum count of each half-month was chosen, averaged over the 8 years. Those numbers were added up to present the phenology of each species in the entire Wadden Sea area. However, trends in different regions of the Wadden Sea might be different from this figure; more detailed and regional phenology data and figures can be found elsewhere (Meltofte *et al.*, 1994).

Subspecies / population
[a] The estimate of the size of each subspecies / population;
[b] The **1% level** with regard to the application of the Ramsar Criterion 6 – *"...a wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbirds..."* (see Chapter 2.7.2);
[c] The trend for each subspecies / population as assessed by Wetlands International (2002); STA – stable, DEC – decreasing, INC – increasing, FLU – fluctuating; the time periods considered for these trend estimates are not the same for all species, but for each species the most recent trend information is chosen (for details and references of trend estimates see Wetlands International, 2002) (see Chapter 2.7.2).

Subspecies / population: Breeding or wintering or core non-breeding range	**Estimate[a]**	**1% level[b]**	**Trend[c]**
canutus: Central Siberia (breeding)	340,000	3,400	DEC
islandica (winter): Greenland, High Arctic Canada (breeding)	450,000	4,500	DEC

	1980-1991[a]	**1992-2000** arithm. mean of 3 max results[b]		**Flyway population[c]**
	estimated	**counted**	**estimated**	**%**
summer	22,800	30,786	43,949	9.8
autumn	352,000	215,599	334,118	74.2
winter *	101,000	147,422	160,232	35.6
spring	**433,000**	201,779	**338,500**	75.2

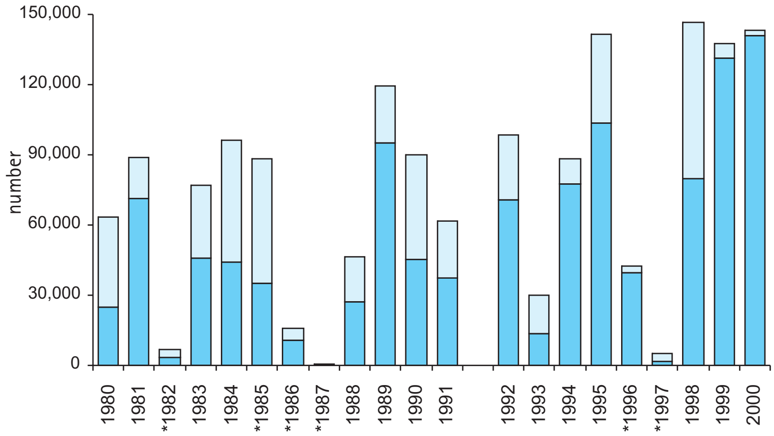
* High numbers in winter are from February counts

	Trend estimates[d]	
	1992-2000[e]	**1980-2000[f]**
overall	--	-
autumn[g]	--	
January	++	++ (n.s.)
spring	F/--	

[a] Estimated number per season for the period 1980-1991 as given by Meltofte *et al.*, 1994; the number of the peak season is printed in **bold**;
[b] Arithmetic mean of the three maximum results of counted and estimated number per season for the period 1992-2000 covered by this report; the estimate of the peak season is printed in **bold**;
[c] Percentage of the flyway population as represented by the estimated number of the period 1992-2000;
[d] substantial increase = ++, increase = +, stable = S, fluctuating = F, decrease = -, substantial decrease = —; n.s. = not significant; if trends within one season are different for different months, trend estimates are separated by a slash (e.g. F/—); in brackets = expert guess uncertain due to fluctuating species numbers.
[e] Short-term overall trend estimate and trend estimates per season for the period 1992-2000;
[f] Long-term overall trend estimate and trend estimate for January numbers;
[g] Seasons are shaded according to the importance of the Wadden Sea for this species yearly cycle and thus trend in the Wadden Sea. For seasons with least importance no trend estimates are given.

dark shading	season is very important
light shading	season is less important
no shading	season is of least importance

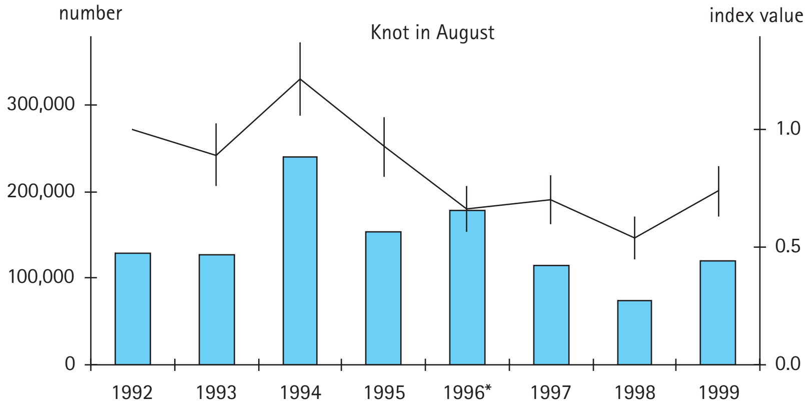
Figure 4.xx: Estimated numbers of the species (here Knot) in January (blue = counted, light blue = imputed).



Counts in January

Bars show the estimated number of individuals per year. The lower part of each bar represents the counted number, the upper part the imputed portion of the estimate. Years with cold winters are marked with an asterisk (*). The space between 1991 and 1992 separates between the two periods (1980-1991 Meltofte *et al.*, 1994; 1992-2000 this report), for which the calculation method of the imputed values has been different.

Figure 4.xx: Species (here Knot) – Counted numbers (bars) and index values (lines) in specific months (here August).



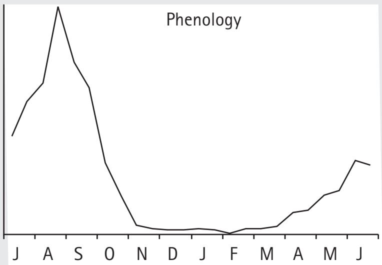
Counts of other months

Bars show the counted number of individuals per year, the left scale applies. The line shows the index values +/- the standard error, the right scale applies, 1992 is chosen as the base year (no standard error, Index value = 1). This line also represents the approximate height of the "estimated values". The year with the international synchronous count is marked with an asterisk (*).

4.1 Great Cormorant

Phalacrocorax carbo

DK: Skarv D: Kormoran NL: Aalscholver 00720



Subspecies / population: Breeding or wintering or core non-breeding range	Estimate	1% level	Trend
N, Central Europe	275,000 - 340,000	3,100	INC

(source: Wetlands International, 2002)

	1980-1991	1992-2000 arithm. mean of 3 max results		Flyway population
	estimated	counted	estimated	%
summer	4,070	6,266	8,013	2.6
autumn	**4,660**	12,826	**17,176**	5.5
winter	84	726	747	0.2
spring	1,080	1,763	2,463	0.8

Trend estimates	1992-2000	1980-2000
overall	++	+
autumn	++	
January		++
spring	++	

For explanation of tables and figure see page 35

Of the many existing populations of Great Cormorant, the sub-population of *Phalacrocorax carbo sinensis* breeding and/or wintering in North and Central Europe and the Mediterranean is estimated at 275,000-340,000 birds and increasing (Wetlands International, 2002). The number of Cormorants breeding within the Wadden Sea Area is 838 pairs in 1996, however the breeding population in the adjacent areas numbered more than 70,000 pairs in 1996 (Rasmussen *et al.*, 2000).

Numbers of Cormorants build up in the Wadden Sea from late March onwards until peak numbers are reached after the breeding season in late August. From September onwards, numbers fall, reaching a low winter level in early November and staying low during winter.

The number of Cormorants present in the Wadden Sea in January have increased from less than hundred until 1992 to several hundreds in recent years with the highest numbers found in The Netherlands.

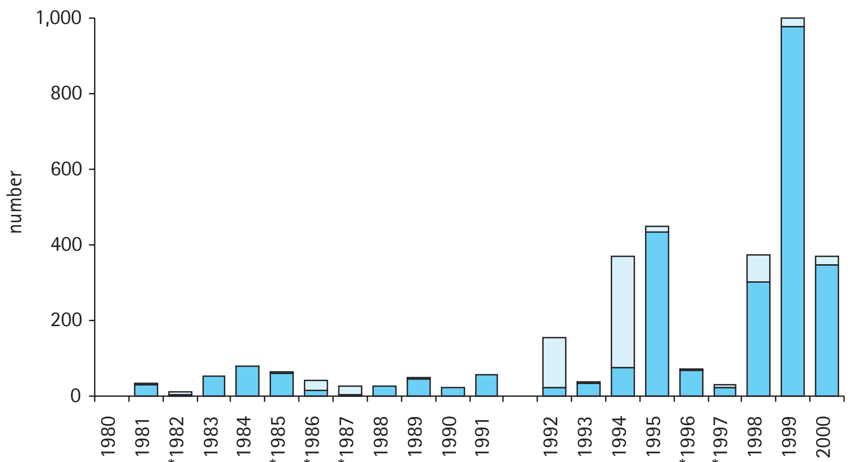


Figure 4.1: Estimated numbers of Great Cormorants in January (blue = counted, light blue = imputed).

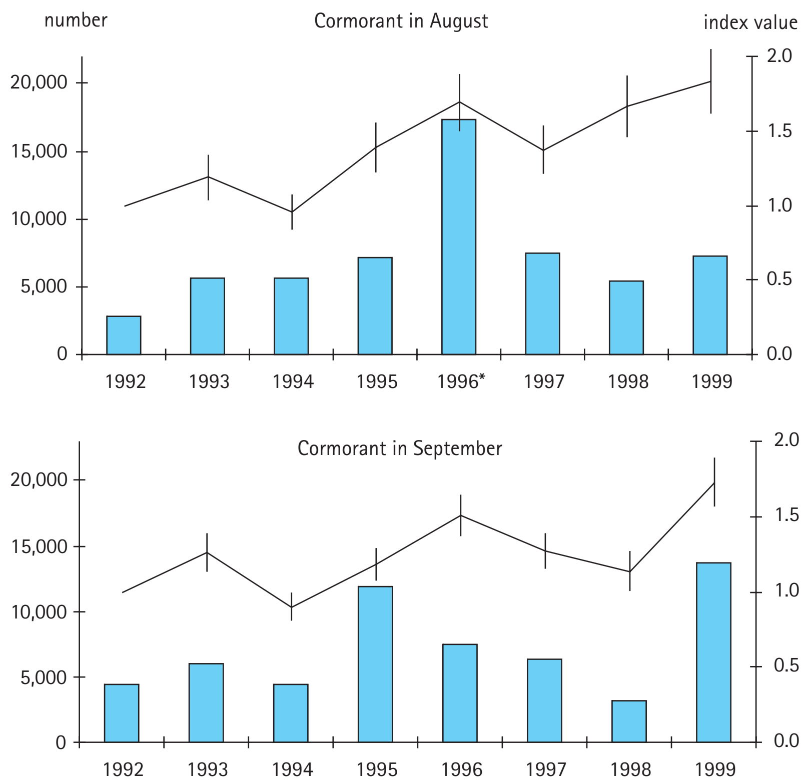


Figure 4.2: Great Cormorant – Counted numbers (bars) and index values (lines) in August and September.

The August count in 1996 yielded a total of 17,900 estimated birds, with almost 50% of those present in The Netherlands and the rest distributed evenly in the other countries. There is a "substantial increase" in August and September.

The number of Cormorants counted in the Wadden Sea Area in spring is larger than the population breeding in the same area (838 pairs in 1996), but still considerably smaller than the actual breeding population in the adjacent areas (more than 70,000 pairs in 1996) (Rasmussen *et al.*, 2000). This suggests that an increasing number of individuals from outside the Wadden Sea stay to moult in the Wadden Sea area (Meltofte *et al.*, 1994).

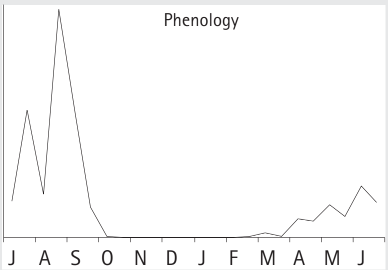
Conclusion

Cormorant numbers started to increase in the Wadden Sea in the 1980s (Meltofte *et al.*, 1994). This increase – during all seasons – continued over the recent years in all parts of the Wadden Sea (van Roomen *et al.*, 2004, Blew *et al.*, 2005, Laursen and Frikke, in prep.). With regard to the overall population increase in Europe (Bregnballe *et al.*, 2003), which has recently been leveling off, Wadden Sea numbers seem to follow the overall population development with some years' delay.

4.2 Eurasian Spoonbill

Platalea leucorodia

DK: Skestork D: Löffler NL: Lepelaar 01440



Subspecies / population: Breeding or wintering or core non-breeding range	Estimate	1% level	Trend
E Atlantic	9,950	100	INC

(source: Wetlands International, 2002)

	1980-1991	1992-2000 arithm. mean of 3 max results		Flyway population
	estimated	counted	estimated	%
summer	**110**	289	294	2.9
autumn	**262**	1,064	**1,087**	10.9
winter	2	0	0	0.0
spring	111	130	137	1.4

Trend estimates		
	1992-2000	1980-2000
overall	++	+
autumn	++	
January		
spring		

For explanation of tables and figure see page 35

The Spoonbill flyway population is estimated at about 9,950 birds and increasing (Wetlands International, 2002). The breeding population in the Wadden Sea increased from 217 in 1991 to 592 pairs in 1996 (Rasmussen *et al.*, 2000). Even though the vast majority still breeds in The Netherlands, breeding pairs are now also found in the Wadden Sea of Niedersachsen, Schleswig-Holstein and as far North as Ringkjøbingfjord and Limfjorden in Denmark.

A short post-breeding peak occurs in August; for example, in Schleswig-Holstein some 30-50 birds move Northeast to moult in the Hauke-Haien Koog together with some local breeders. At the latest in September, most of the birds have moved south towards the Western Mediterranean and West African coastal range (Overdijk *et al.*, 2001).

From October to March the Wadden Sea is practically deserted, before breeding birds begin to move in during late March and early April.

Along with the increasing numbers of breeding Spoonbills, the non-breeding numbers have increased compared to the former decade. Peak numbers are in August 1996 with 1,320 counted birds, (of those 1,260 alone in the NL), showing a "substantial increase" from 1992-2000, and far exceeding the maximum count of 262 birds during the previous decade.

Conclusion

Both the Spoonbill breeding population as well as numbers of Spoonbills staying in the Wadden Sea after breeding show a steady and continued increase; the distribution extends northwards.

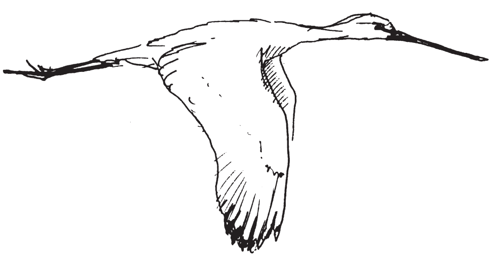
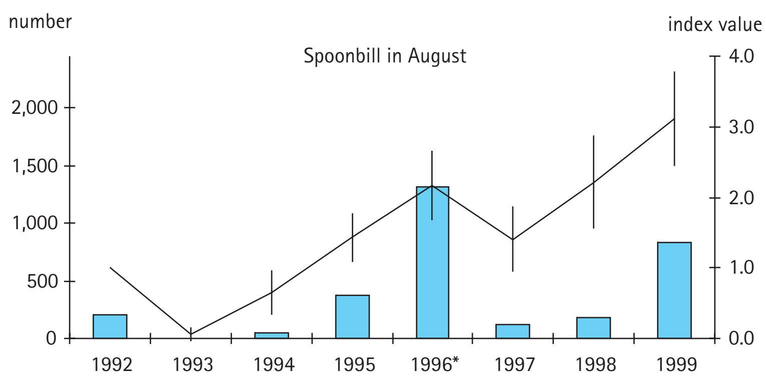


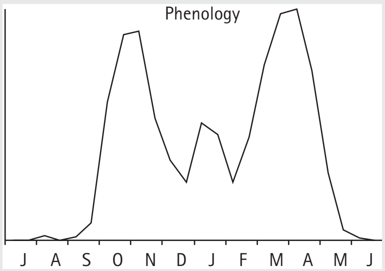
Figure 4.3
Eurasian Spoobill – Counted numbers (bars) and index values (lines) in August.



4.3 Barnacle Goose

Branta leucopsis

01670 DK: Bramgås D: Weißwangengans NL: Brandgans



Subspecies / population: Breeding or wintering or core non-breeding range	**Estimate**	**1% level**	**Trend**
N Russia, E Baltic (breeding)	360,000	3,600	INC

(source: Wetlands International, 2002)

	1980–1991	1992–2000 arithm. mean of 3 max results		Flyway population
	estimated	counted	estimated	%
summer	22	192	205	0.1
autumn	78,600	176,609	230,560	64.0
winter	103,000	105,384	188,529	52.4
spring	**62,600**	166,760	**251,139**	69.8

Trend estimates	1992–2000	1980–2000
overall	++	+
autumn	F	
January	F	++
spring	F/+	

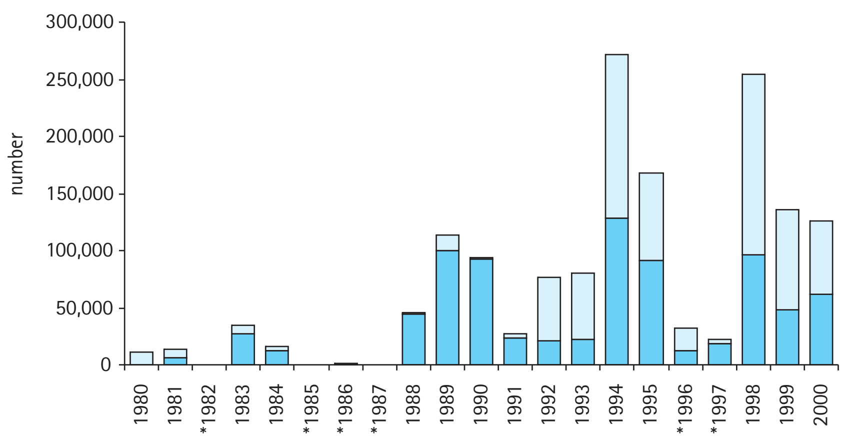
For explanation of tables and figure see page 35

The population of Barnacle Geese wintering in North Germany and The Netherlands is estimated at 360,000 birds and increasing (Wetlands International, 2002).

Some 10,000-15,000 Barnacle Geese of the Baltic population arrive in the Wadden Sea as early as mid-September. They are followed by a much larger number of the Russian population in October after these have spent some time in Baltic areas (Madsen *et al.*, 1999). A large proportion stays the entire winter in the area, however Barnacles also use habitats outside the Wadden Sea; thus our counts reflect the varying use of Wadden Sea habitats during this season. Until April, Barnacle Geese move northwards within the Wadden Sea until they leave for the breeding grounds in late April and early May (Koffijberg and Günther, 2005, this volume).

January numbers 1992-2000 show large fluctuations and thus cannot be used to project a trend. In 1994, a peak of 128,800 birds was counted (272,000 estimated) (within +/- 2 days around the counting date). Numbers have increased compared to the previous decade, when a maximum of some 100,000 counted birds occurred in 1989, but most counts yielded comparable values.

Figure 4.4: Estimated numbers of Barnacle Goose in January (Goose countig dates +/- 2 days) (blue = counted, light blue = imputed).



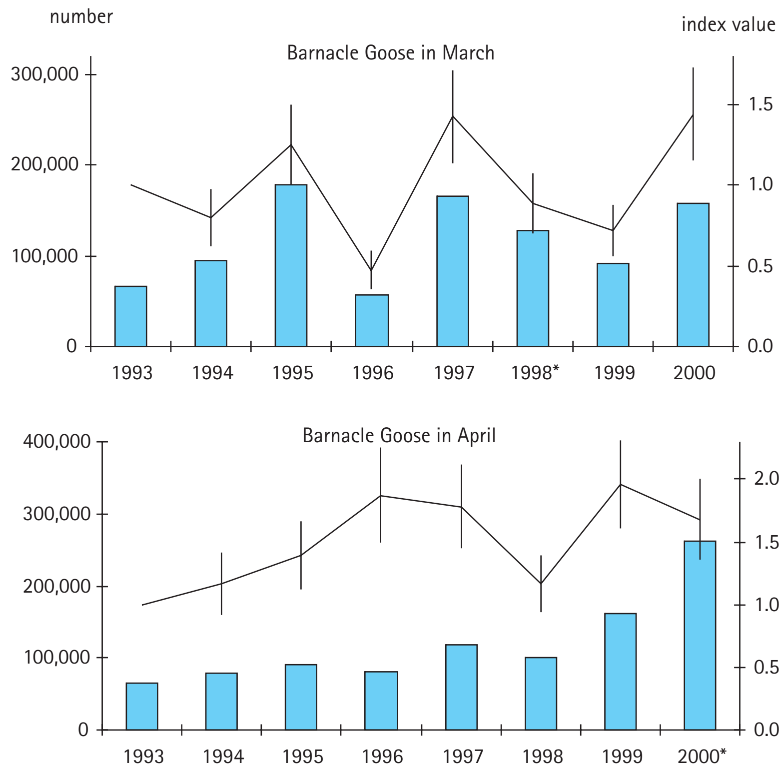


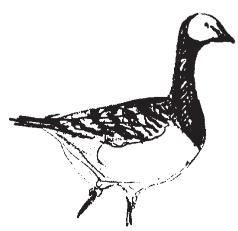
Figure 4.5: Barnacle Goose - Counted numbers (bars) and index values (lines) in March and April (Goose countig dates +/- 2 days).

Data for autumn months show large fluctuations. Compared to the previous decade numbers have considerably increased with several October and November counts showing more than 120,000 counted birds.

In March for three years, numbers with more than 150,000 counted birds are considerably higher than during the former decade (a maximum of 261,500 birds estimated in 1997), yet no significant trend can be detected. The April counts also show fluctuating numbers. However, the count in early April 2000 yielded an outstandingly high result with 298,300 estimated Barnacle Geese, a number not reached in previous years. For May 1992-2000, counted numbers of 47,200 in 1999 and even 80,700 in 2000 and the fact the trend estimate for May numbers is an "increase", substantiate the observations that Barnacles might have changed their phenology in comparison to the former decade, that is, birds seem to stay longer in the Wadden Sea before they leave for their breeding grounds (for more details see Koffijberg and Günther, 2005, this volume).

Conclusion

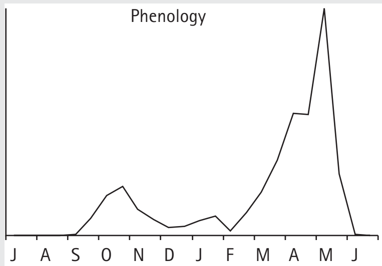
Apart from an "increase" in May, which does not fall within the peak time of the Barnacle migration period, no significant trends could be detected in any other months. However, there is a long-term increase, and during 1992-2000 too, overall numbers indicate an increase. The increase co-incides with an increase of the Russian-Baltic flyway population, a prolonged stay in the Wadden Sea habitats, the expansion of feeding sites bordering the Wadden Sea and a probable shift to a later departure towards the breeding grounds (for details see Koffijberg and Günther, 2005, this volume).



4.4 Dark-bellied Brent Goose

Branta bernicla bernicla

01680 DK: Mørkbuget Knortegås
D: Dunkelbäuchige Ringelgans NL: Rotgans



Subspecies / population: Breeding or wintering or core non-breeding range	Estimate	1% level	Trend
W Siberian (breeding)	215,000	2,200	DEC

(source: Wetlands International, 2002)

	1980-1991	1992-2000 arithm. mean of 3 max results		Flyway population
	estimated	counted	estimated	%
summer	356	937	1,133	0.5
autumn	117,000	61,905	75,151	34.2
winter	35,200	33,316	42,092	19.1
spring	**220,000**	215,599	**260,457**	118.4

Trend estimates	1992-2000	1980-2000
overall	--	S
autumn	--	
January	--	+ (n.s.)
spring	--	

For explanation of tables and figure see page 35

The West-Siberian breeding population of the Dark-bellied Brent Goose is now estimated at 215,000 individuals, decreasing from an estimate of 250,000-300,000 in the 1990s (Madsen *et al.*, 1999; Wetlands International, 2002).

Brent Geese move into the Wadden Sea from staging sites in Northern Russia during late September and early October, reaching maximum numbers in October. By November most of the birds have left the Wadden Sea westwards to wintering grounds at coasts of Great Britain and France. Birds come back in March and reach peak numbers in April and May. Then, practically the entire population may utilize the Wadden Sea, with large proportions being present in The Netherlands and Schleswig-Holstein. Birds leave during May to their breeding grounds (Meltofte *et al.*, 1994; Madsen *et al.*, 1999; Koffijberg and Günther, 2005, this volume).

In January, estimated numbers of overwintering Brent Geese in the Wadden Sea area reach some 50,000 of which more than 80% are counted in The Netherlands. As is the case with most duck species, a long stretch of mild winters results in comparably high numbers up to 1995, whereas the numbers consider-

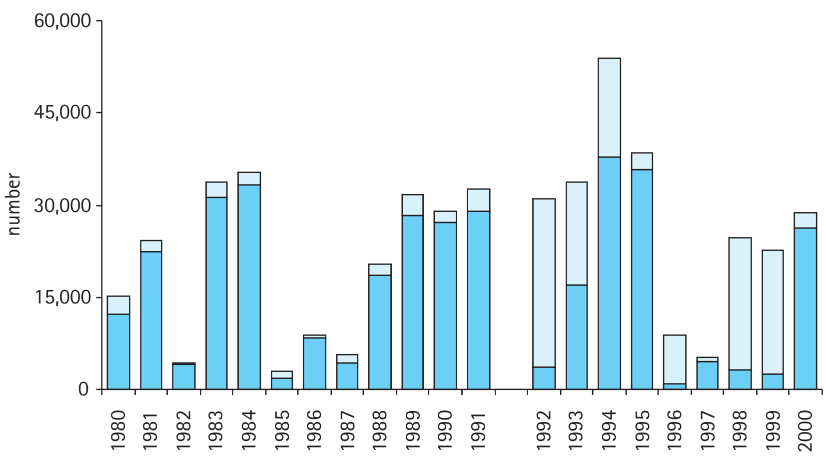


Figure 4.5: Estimated numbers of Dark-bellied Brent Goose in January (Goose countig dates +/- 2 day) (blue = counted, light blue = imputed).

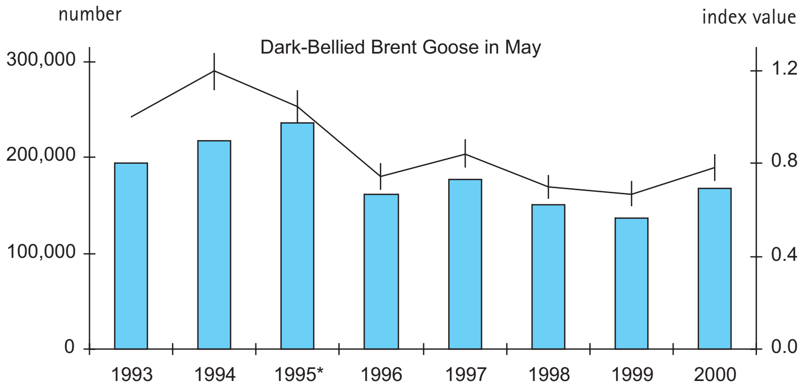


Figure 4.6: Dark-bellied Brent Goose – Counted numbers (bars) and index values (lines) in May (Goose countig dates +/- 2 days).

ably decrease during the cold winters and stay on a lower level subsequently. Trend parameters for January show a "substantial decrease" between 1992 and 2000; however, compared to the last decade, the long term winter trend seems to be stable, including large fluctuations.

For March 1992-2000, the synchronous count (and goose count) in 1998 yielded a single peak of 118,000 counted Brent Geese (137,600 estimated), thus far exceeding March numbers for all years before and after. During the synchronous count in April 2000, 184,700 birds were counted (209,200 estimated). In May counts from 1994 and 1995, a maximum count of 235,900 Brent Geese and a maximum estimate of 288,500 exist; this might well represent close to 100% of the flyway population. Clearly, the peak numbers in spring up to 1996 are higher than those of the previous decade. Trend estimates for the spring period 1992-2000 are not significant for March and April, however, in March, numbers seem to increase, whereas April numbers fluctuate on one level. For May, the peak migration month, there is a "substantial decrease"; here, numbers drop continuously after 1995; since there is a trend of increasing numbers in April, it could be suspected that the peak of staging Brent Geese has moved forwards in the year. However, so far no daytime departures have been observed earlier than mid-May.

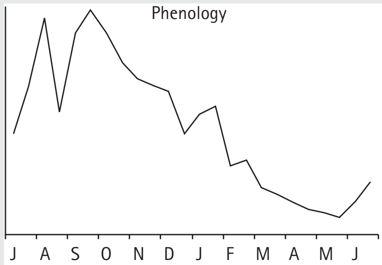
Conclusion

The numbers of Brent Geese showed a long-term increase up to 1996 (Madsen *et al.*, 1999), but have decreased overall from then on. This decrease is observed mainly in spring, and thus applies to practically the entire population of Dark-bellied Brent Goose concentrating in the international Wadden Sea during this season. In contrast to this overall decrease, the increase of numbers in March may indicate an earlier arrival in the Wadden Sea and thus a change of migration behavior of this species. The main reasons for the decrease of overall numbers might be the low reproduction rates (breeding success) (for details see Koffijberg and Günther, 2005, this volume).

4.5 Common Shelduck

Tadorna tadorna

01730 DK: Gravand D: Brandgans NL: Bergeend



Subspecies / population: Breeding or wintering or core non-breeding range	Estimate	1% level	Trend
NW Europe (breeding)	300,000	3,000	STA

(source: Wetlands International, 2002)

	1980-1991	1992-2000 arithm. mean of 3 max results		Flyway population
	estimated	counted	estimated	%
summer	34,700	86,081	137,683	45.9
autumn	**254,000**	136,898	218,943	73.0
Aug-aerial counts moulting birds	no data	**211,541**	**211,541**	70.5
winter	178,000	134,777	183,326	61.1
spring	86,800	32,424	44,980	15.0

Trend estimates	1992-2000	1980-2000
overall	+ (n.s.)	+
autumn	+	
January	+	F
spring		

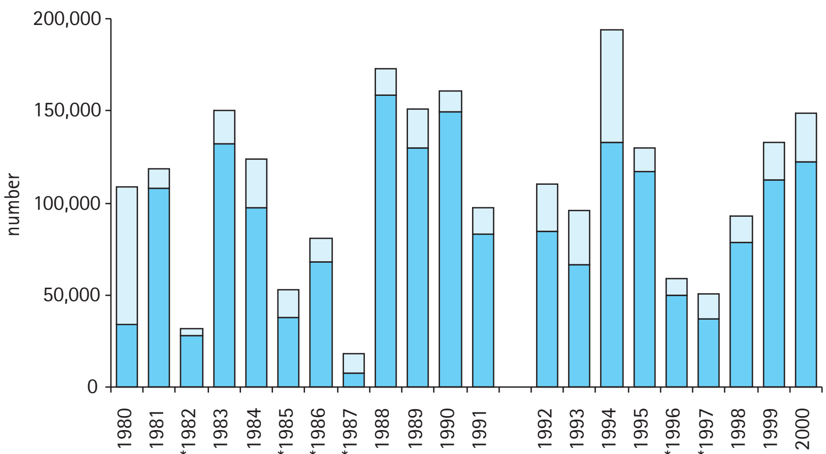
For explanation of tables and figure see page 35

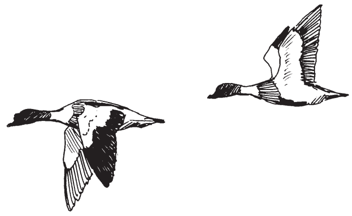
The population of Shelduck breeding in Northwest Europe and wintering in West Europe is estimated at 300,000 and stable (Wetlands International, 2002). The current breeding population in the Wadden Sea is estimated at some 5,000 pairs in 1996 (Rasmussen *et al.*, 2000).

Numbers of Shelduck in the Wadden Sea start to build up shortly after the breeding season, when almost the entire Northern and Western European population concentrates at their moulting site in the outer Elbe river-mouth near the Friedrichskoog Peninsula (Schleswig-Holstein) (aerial counts, *e.g.* Kempf, 2001). Numbers counted from the ground show a peak in September/October. Numbers of birds wintering in the Wadden Sea build up in September, originating mainly from Southern Scandinavia and the Baltic (Meltofte *et al.*, 1994). Numbers drop throughout the following months coming to a low in May. From September onwards, Shelducks are more equally distributed in the international Wadden Sea. However, even in cold winters, large proportions of the birds present are still counted in Schleswig-Holstein.

The January counts clearly show that some, although not all, Shelducks leave the Wadden Sea in cold winters, mainly to the British Isles and even to the western Mediterranean (Mel-

Figure 4.7: Estimated numbers of Shelduck in January (blue = counted, light blue = imputed).





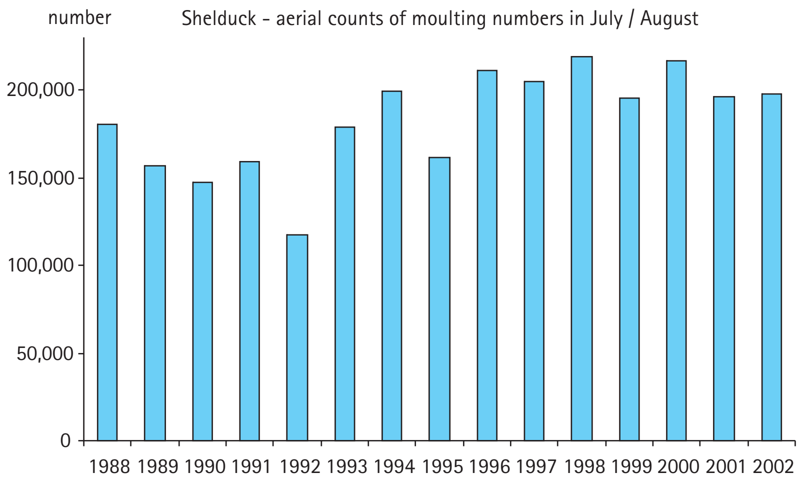


Figure 4.8: Shelduck – Moulting numbers. Results of aerial counts in the Schleswig-Holstein Wadden Sea, data combined from three separate counts in each year between 28 July and 8 August.

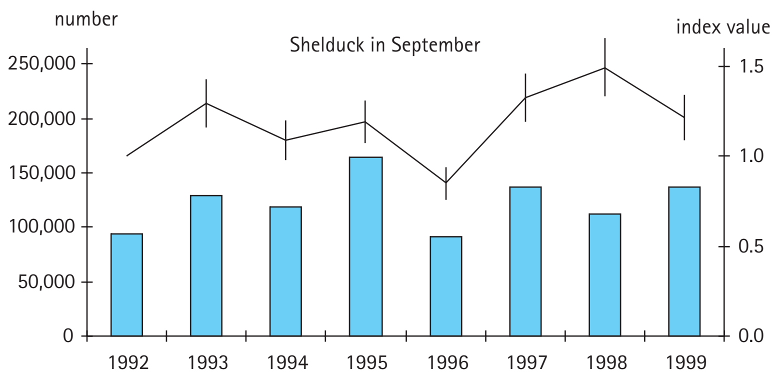


Figure 4.9: Shelduck – Counted numbers (bars) and index values (lines) in September.

tofte *et al.*, 1994); they may also stay out of sight on ice-covered tidal flats. The trend parameters in January for the period 1992-2000, excluding the cold winters, show an "increase". Compared to the period 1980-1991, January numbers do not show a marked change, partly due to the considerably fluctuating numbers.

The moulting individuals in July and August can only be counted from the air. Those numbers show a slight increase up to 1996, after which numbers vary around 200,000 birds (Kempf, 1997, 1999, 2001).

During September, when ground counts deliver reasonable numbers again, a peak was reached with 164,700 counted individuals in 1995, estimated numbers reach a peak in 1998, however, with high imputed numbers in Denmark and The Netherlands. Trend parameters for September 1992-1999 show an "increase", in October numbers fluctuate, in November they are "stable". The trend for October is similar to that for September, but shows a low in 1995 and a high in 1996. Compared to the previous decade, numbers seem to be stable; however, peaks of counted numbers such as 231,000 birds in November 1980, have not been reached again (Meltofte *et al.*, 1994).

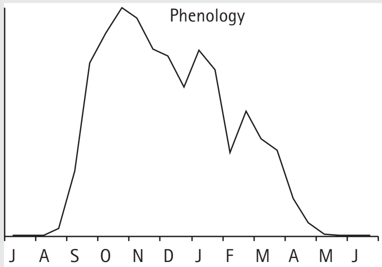
Conclusion

The numbers of Shelduck during moult and migration in the Wadden Sea seem to be stable, with slight increases in some seasons and areas. In Germany, where most of the birds stay during moult, numbers dropped slightly after 1990, but have been stable in recent years (Blew *et al.*, 2005). In The Netherlands, recent numbers have been stable (van Roomen *et al.*, 2004), in Denmark they are increasing (Laursen and Frikke, in prep.).

4.6 Eurasian Wigeon

Anas penelope

01790 DK: Pibeand D: Pfeifente NL: Smient



Subspecies / population: Breeding or wintering or core non-breeding range	Estimate	1% level	Trend
NW Europe (non-breeding)	1,500,000	15,000	INC?

(source: Wetlands International, 2002)

	1980-1991	1992-2000 arithm. mean of 3 max results		Flyway population
	estimated	counted	estimated	%
summer	436	1,484	1,666	0.1
autumn	**320,000**	191,854	**332,596**	22.2
winter	138,000	223,648	269,692	18.0
spring	96,200	84,558	121,874	8.1

Trend estimates	1992-2000	1980-2000
overall	--	S
autumn	--	
January	--	++
spring	-	

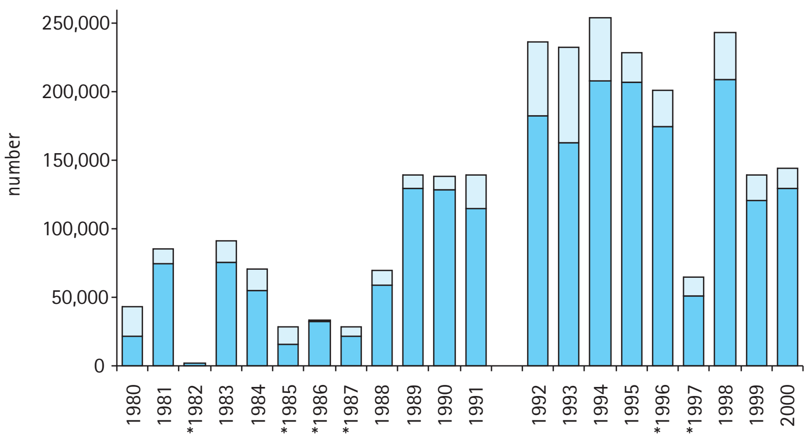
For explanation of tables and figure see page 35

The population of Wigeon wintering in Northwest Europe is estimated at 1,500,000 individuals and increased up to 1995, before leveling off (Wetlands International, 2002).

Wigeon from Northern breeding grounds arrive in the Wadden Sea area in September and reach peak numbers in October; apparently, Wigeon reach their peak numbers in the Wadden Sea sites earlier than on inland sites (van Eerden, 1990). In mild winters most of the birds stay through February, however, in cold winters, large proportions leave for Great Britain and France. Numbers keep falling during late winter until April, when the birds leave the Wadden Sea again towards their breeding grounds (Meltofte *et al.*, 1994).

A maximum count of 254,260 Wigeon has been reached in December 1994, representing the highest counted result of all seasons. At the end of a period of increase during the mild winters after 1987, January numbers reach counted totals of more than 200,000 in 1994, 1995 and 1998 with large proportions in Schleswig-Holstein and The Netherlands. The high numbers in January 1998 were influenced by extremly mild weather during January, which led many Wigeon to migrate back to the Wadden Sea from wintering grounds. In cold winters, the overall numbers are lower and

Figure 4.9: Estimated numbers of Wigeon in January (blue = counted, light blue = imputed).



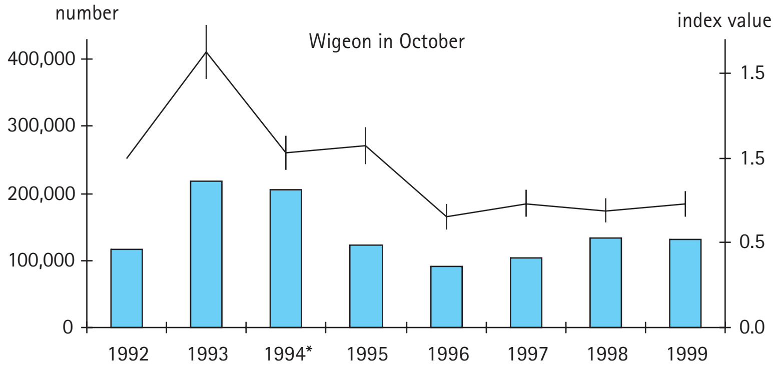


Figure 4.10: Wigeon - Counted numbers (bars) and index values (lines) in October.

the proportion of birds staying in The Netherlands becomes larger. Trend parameters for January 1992-2000, excluding the cold winters, indicate a "substantial decrease", mainly to the low numbers in 1999 and 2000, dropping back to the results of 1989-1991. However, compared to the period 1980-1991 the recent results are considerably higher and the long-term trend 1980-2000 is an increase. This is even more remarkable because the more recent numbers are counted only in the "co-operation area" of the Wadden Sea (Wadden Sea Area) (see Chapter 2.2), whereas for the previous analyses data from areas directly adjacent to the "cooperation area" had been included.

Peak counted numbers of Wigeon in October reached more than 200,000 in 1993 and 1994; in 1993, some 425,000 Wigeon were estimated, however, almost half of those are imputed, especially in Schleswig-Holstein. Counted numbers in 1992-2000 do not reach the peak of 300,000 counted Wigeon in October 1984 (Meltofte *et al.*, 1994). Trends in October and November both show "substantial decreases" of Wigeon.

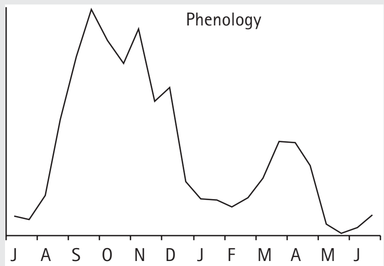
Conclusion

In line with the trend development of the flyway population, Wigeon numbers in the Wadden Sea during winter and migration experienced a long term increase up to 1995. Whereas the flyway population remains at a high level, for the Wadden Sea, both for January and for autumn months October and November decreases are recorded after 1995. It has been suggested that the proportion of the Wigeon population staying in Wadden Sea habitats had increased, due to the habitat improvements within the Wadden Sea Area (new embanked areas, polders) (*e.g.* Brunckhorst and Rösner, 1998). The recent decreases during the yearly cycle might have been aggravated by additional winter mortality due to the cold winters of 1996 and 1997 In Schleswig-Holstein overall numbers dropped some 50% after 1995 (Günther and Rösner, 2000), resulting from decreases in Germany in all seasons (Blew *et al.*, 2005). Most recent Wigeon numbers appear to be stable in the Dutch Wadden Sea (van Roomen *et al.*, 2004) and increasing in Denmark (Laursen and Frikke, in prep.).

4.7 Common Teal

Anas crecca

01840 DK: Krikand D: Krickente NL: Wintertaling



Subspecies / population: Breeding or wintering or core non-breeding range	Estimate	1% level	Trend
NW Europe (non-breeding)	400,000	4,000	STA

(source: Wetlands International, 2002)

	1980-1991	1992-2000 arithm. mean of 3 max results		Flyway population
	estimated	counted	estimated	%
summer	1,120	1,685	2,217	0.6
autumn	**56,600**	26,227	**38,706**	9.7
winter	19,000	17,792	26,695	6.7
spring	8,490	9,602	14,678	3.7

Trend estimates		
	1992-2000	1980-2000
overall	F	S
autumn	F	
January		F
spring	++	

For explanation of tables and figure see page 35

The population of Teal wintering in Northwest Europe is estimated at 400,000 and stable (Wetlands International, 2002).

Only a small part of the Northwest European Teal population uses the Wadden Sea during their yearly cycle, most of them are widely distributed along coastal and inland habitats (Meltofte *et al.*, 1994). In the Wadden Sea, numbers increase in August with up to 20,000 birds staying from September until November. In winter most birds leave the Wadden Sea, in cold winters more or less completely. Numbers build up again in March and April but are low during the summer.

In winter, Common Teal show a considerable dependence on the weather, thus, Teal numbers or trends in January are not very indicative for calculating trends, the long-term January trend is fluctuating.

Autumn numbers show varying trends such as "substantial decreases" in September and November, but an "increase" in October. These fluctuations are not understood, but they suggest that depending on weather and habitat conditions Teal will use the Wadden Sea habitats in

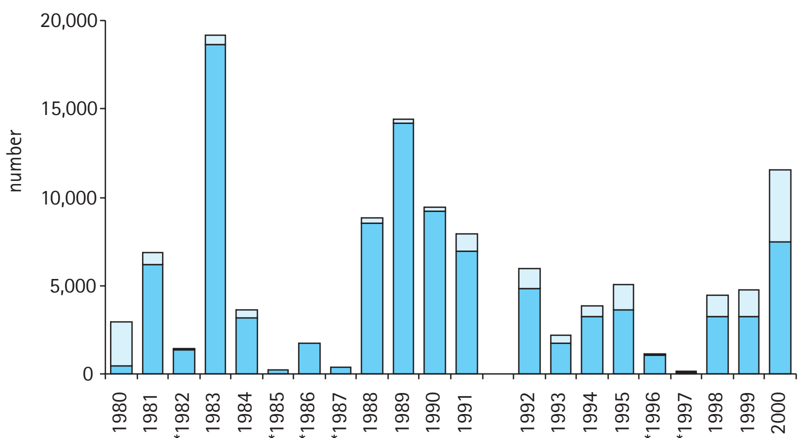


Figure 4.11: Estimated numbers of Teal in January (blue = counted, light blue = imputed).

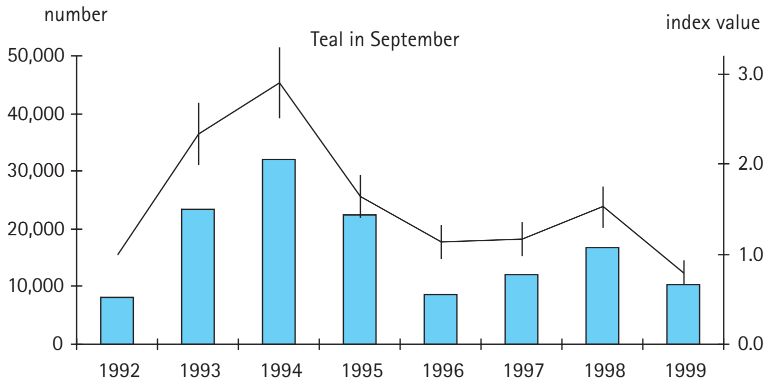


Figure 4.12: Teal - Counted numbers (bars) and index values (lines) in September.

varying proportions during their stay in autumn. For Denmark, it has been shown, that the numbers of Teal present in autumn correlate significantly with the number of breeding pairs (Laursen and Frikke, in prep.). Compared to the period 1980-1991 numbers in the Wadden Sea have slightly dropped; whereas in the first period a peak count of almost 52,000 was reached in September 1981, the highest count in the latter period is from September 1994 with 32,000 individuals counted (45,800 estimated).

In spring, at most 14,000 birds were counted during the synchronous count in April 2000; most spring counts 1992-2000 yielded higher results compared to the former decade. Trend estimates for March, April and May are all "substantial increases".

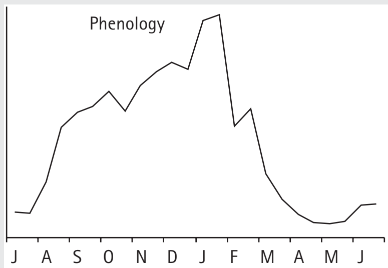
Conclusion

While the short term trend of Teal seems to be stable, numbers show considerable fluctuations and different trends are found for different months; reasons for this may be found in salt marsh management, habitat availability or breeding success of the resident birds. While Germany reports fluctuating Teal numbers (Blew *et al.*, 2005), in the Dutch Wadden Sea, a strong increase has been reported for the recent decade (van Roomen *et al.*, 2004).

4.8 Mallard

Anas platyrhynchos

01860 DK: Gråand D: Stockente NL: Wilde Eend



Subspecies / population: Breeding or wintering or core non-breeding range	Estimate	1% level	Trend
NW Europe (non-breeding)	4,500,000	20,000	DEC

(source: Wetlands International, 2002)

	1980–1991	1992–2000 arithm. mean of 3 max results		Flyway population
	estimated	counted	estimated	%
summer	22,900	14,654	19,108	1.0
autumn	136,000	72,339	109,608	5.5
winter	**165,000**	131,636	**170,157**	8.5
spring	57,700	21,447	35,183	1.8

Trend estimates	1992–2000	1980–2000
overall	--	-
autumn	--	
January	-	+ (n.s.)
spring		

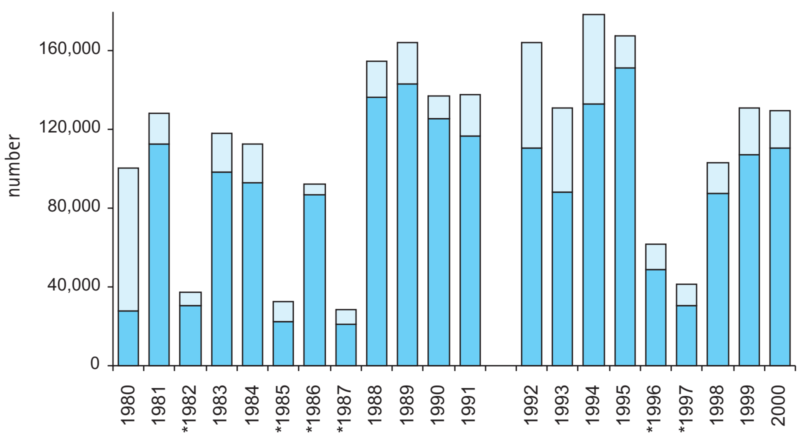
For explanation of tables and figure see page 35

The population of Mallard wintering in Northwest Europe and East to the Baltic area is estimated at 4,500,000 individuals and decreasing (Wetlands International, 2002).

Mallards are present in the Wadden Sea mainly from late summer to February; then birds leave north to their breeding grounds. Only a small part of the estimated population uses the Wadden Sea during their yearly cycle (Meltofte *et al*., 1994).

In January counts between 1988 and 1996, a more or less continuous period of mild winters, numbers were higher than before and after this period. In 1995, the counted numbers reached 151,100 individuals (167,500 estimated), the highest counted number in all years, the highest estimate was reached in 1994 with 178,300. The January trend 1992-2000 shows a "decrease" of 4% per year when excluding the cold winters from the calculation, the trend 1980-2000 suggests an increase, but is not significant and fluctuates with the climatic conditions.

Figure 4.13: Estimated numbers of Mallard in January (blue = counted, light blue = imputed).



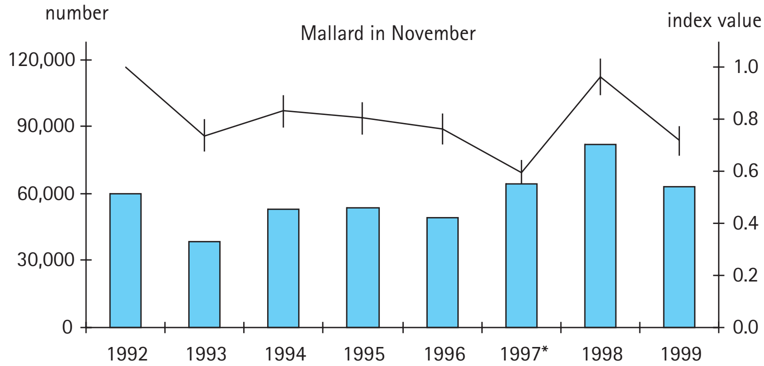


Figure 4.14: Mallard - Counted numbers (bars) and index values (lines) in November.

While the rather low spring numbers already indicate "decreases" both for March and April, during autumn, the main migratory period in the Wadden Sea, trend parameters for September and October both indicate a "substantial decrease" and a moderate "decrease" in November. In addition, peak estimates during these months from the former decade (105,500 in September 1981, 92,800 in October 1984 and 135,600 in November 1987) have not been reached again since.

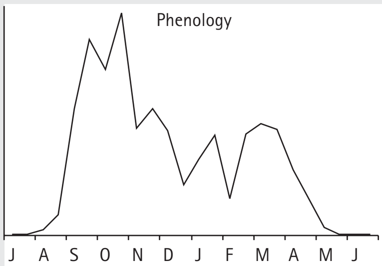
Conclusion

For the entire Wadden Sea 1992-2000, an overall substantial decrease of Mallards can be stated for the short-term period. While numbers in January seem stable in the long-term, the long-term trend for the migration period in autumn is also a decrease. Germany calculates a considerable drop of overall numbers after 1993 (Blew *et al.*, 2005), whereas for the Dutch Wadden Sea, stable numbers are reported (van Roomen *et al.*, 2004).

4.9 Northern Pintail

Anas acuta

01890 DK: Spidsand D: Spießente NL: Pijlstaart



Subspecies / population: Breeding or wintering or core non-breeding range	Estimate	1% level	Trend
NW Europe (non-breeding)	60,000	600	DEC

(source: Wetlands International, 2002)

	1980-1991	1992-2000 arithm. mean of 3 max results		Flyway population
	estimated	counted	estimated	%
summer	98	109	133	0.2
autumn	**16,200**	12,180	**15,901**	26.5
winter	15,200	11,129	14,412	24.0
spring	10,100	9,494	13,397	22.3

Trend estimates	1992-2000	1980-2000
overall	- (n.s.)	F
autumn	F	
January	F	+ (n.s.)
spring	F	

For explanation of tables and figure see page 35

The population of Pintail wintering in Northwest Europe is estimated at 60,000 individuals and decreasing. Other large flyway populations of this species are found in almost the entire world (Wetlands International, 2002).

Pintail utilize the Wadden Sea during their migration and wintering period from September to April, reaching the highest numbers regularly in September and October. From then on, counted numbers decrease with some fluctuations. A short and small peak occurs in March or April, before the Pintail leave Wadden Sea areas for their breeding grounds.

Quite a lot of Pintail stay in the Wadden Sea during mild winters, of which most move west- and southwards with major proportions in The Netherlands. In January 1995, a total of 13,900 birds was estimated (11,500 counted), 6,800 of those counted alone in The Netherlands. Winter movements are more pronounced in cold winters, e.g. in 1997, Pintail leave the Wadden Sea altogether. A trend in winter is highly dependent on

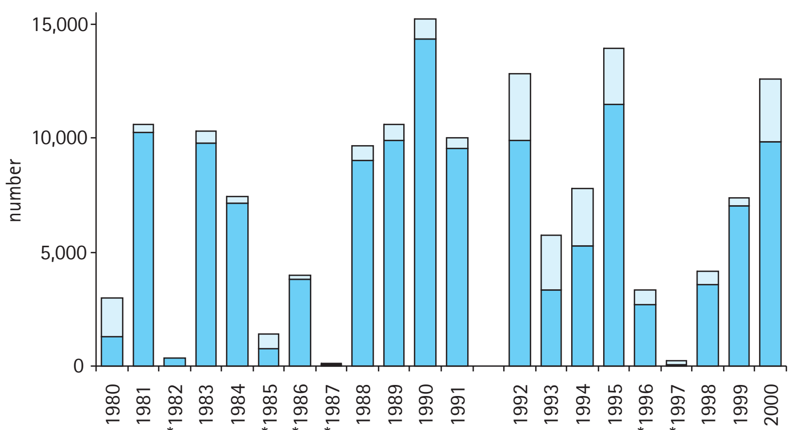


Figure 4.15: Estimated numbers of Pintail in January (blue = counted, light blue = imputed).

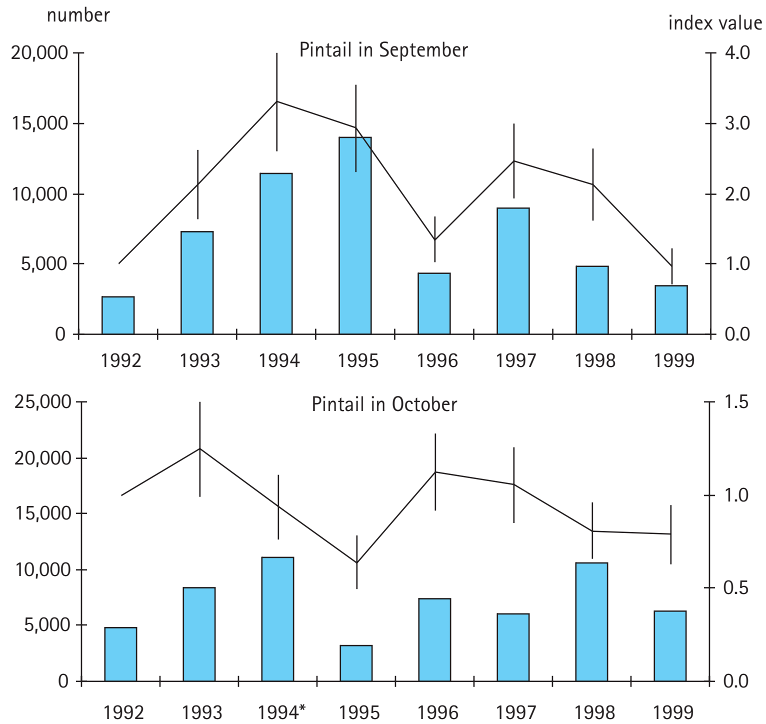


Figure 4.16: Pintail - Counted numbers (bars) and index values (lines) in September and October.

the actual weather and thus is of limited value. January peak numbers correspond well with those of the previous decade.

Up to 17,300 Pintail were estimated September 1995 (11,500 counted). Trend parameters in September and October both tend towards a decrease, again, data is insufficient to make any of these significant. Since the trend patterns in September, October and November are different from each other, it seems that utilization of the Wadden Sea varies considerably with actual environmental conditions (water-levels in inland wetlands, food availability, weather etc.) or breeding success (Laursen and Frikke, in prep.).

Numbers in spring reached 12,300 counted birds during the synchronous count in March 1998 (14,800 estimated), however, in March 1994 the estimated number went up to 17,100 birds. There are no significant trend estimates for this season.

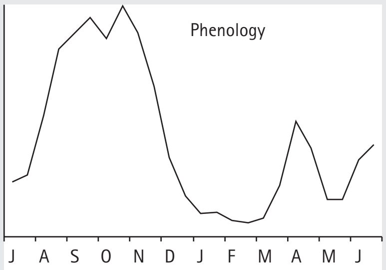
Conclusion

Numbers of Pintail fluctuate during the migratory and winter months, all trends in the main migration periods indicate a decrease, resulting in an overall decrease during 1992-2000, however, not a significant one. The total numbers in all seasons are not notably different from those of the previous decade (Meltofte *et al.* 1994). The situation of the Pintail in the Wadden Sea should be observed further, especially since the flyway population is reported to be "decreasing" (Wetlands International, 2002). In the Dutch Wadden Sea, numbers of Pintail show large fluctuations (van Roomen *et al.*, 2004), in Germany, fluctuating numbers are registered (Blew *et al.*, 2005) and Denmark recently reports decreasing numbers (Laursen and Frikke, in prep.).

4.10 Northern Shoveler

Anas clypeata

01940 DK: Skeand D: Löffelente NL: Slobeend



Subspecies / population: Breeding or wintering or core non-breeding range	Estimate	1% level	Trend
NW & Central Europe (non-breeding)	40,000	400	STA

(source: Wetlands International, 2002)

	1980–1991	1992–2000 arithm. mean of 3 max results		Flyway population
	estimated	counted	estimated	%
summer	1,849	1,297	2,016	5.0
autumn	**3,960**	3,795	**6,031**	15.1
winter	3,610	1,211	1,741	4.4
spring	868	1,894	2,864	7.2

Trend estimates	1992–2000	1980–2000
overall	F	(+)
autumn	F/-	
January		+ (n.s.)
spring	++	

For explanation of tables and figure see page 35

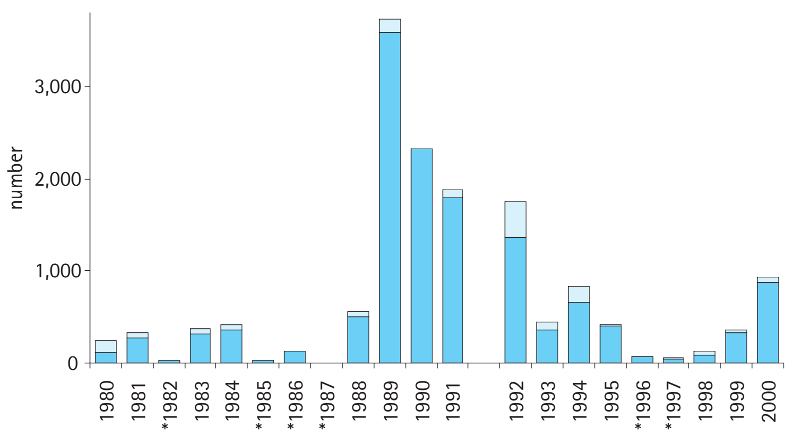
The population of Shoveler wintering in Northwest and Central Europe is estimated at 40,000 and stable (Wetlands International, 2002).

Highest numbers of Shoveler occur in the Wadden Sea during autumn migration with largest proportions present in Schleswig-Holstein found mainly in embanked areas with freshwater wetlands. By the end of November, most individuals have left the Wadden Sea, and in January, numbers are generally low with 500 -1,000 birds in normal winters; the high January numbers in the years 1989-1992 seem to be an exception.

In October, counted numbers are above 3,000 in three years, imputed numbers reach estimates over 6,000 in 1997. Compared to the period 1980-1991 (Meltofte *et al.*, 1994), recent autumn numbers are higher. Yet, they still represent only a fraction of the entire Shoveler population. During autumn migration data are not sufficient to estimate trends; they indicate a decrease in September, while no trend can be detected in October and November.

In April, the short migration wave includes peaks of up to 2,200 counted (3,200 estimated)

Figure 4.17: Estimated numbers of Shoveler in January (blue = counted, light blue = imputed).



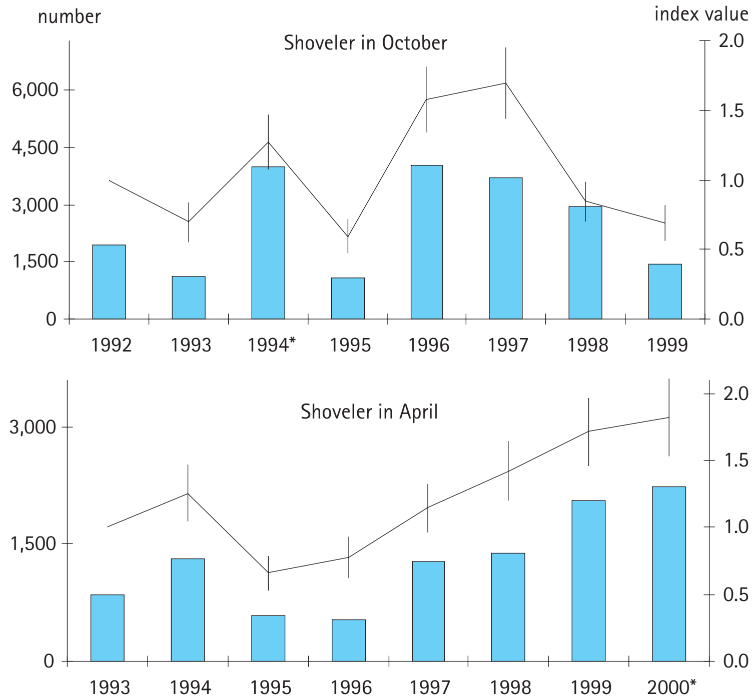
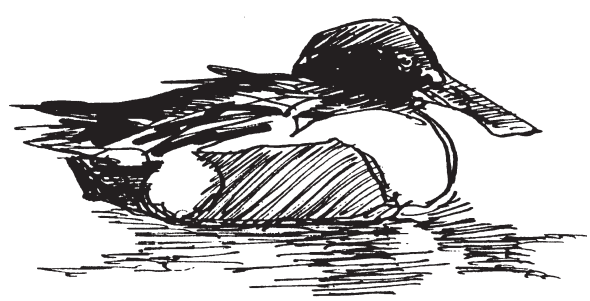


Figure 4.18: Shoveler - Counted numbers (bars) and index values (lines) in October and April.

individuals in April 2000. Apparently, those numbers have been increasing during the recent decade and the trend estimate is a "substantial increase". Also, compared to the previous period when numbers in April were around 400 and 600 birds, an increase can be noted.

Conclusion

Numbers of Shoveler in the Wadden Sea represent only a fraction of the flyway population. No clear trend estimates can be derived for most data, however, April numbers show an increase. The occurrence of larger numbers during the period of mild winters lasted only for a few years and numbers decreased again in those mild winters following when shorter periods with frost occurred; however, this decrease is the opposite of the winter movements to most other duck species in the Wadden Sea. For the migratory periods the generally low numbers have increased compared to the former decade, maybe as a result of salt marsh management.



4.11 Common Eider

Somateria mollissima

02060 DK: Ederfugl D: Eiderente NL: Eidereend

(no good phenology data available, see Scheiffarth and Frank, 2005, this volume)

Subspecies / population: Breeding or wintering or core non-breeding range	**Estimate**	**1% level**	**Trend**
Baltic, Wadden Sea	850,000 - 1,200,000	10,300	DEC

(source: Wetlands International, 2002)

	1980–1991	**1992–2000** arithm. mean of 3 max results		**Flyway population**
	estimated	**counted**	**estimated**	**%**
summer	82,000	66,565	104,362	10.1
autumn	128,000	77,124	114,533	11.1
winter	133,000	126,755	181,441	17.6
winter aerial counts	**309,000**	311,318	**311,318**	30.2
spring	127,000	72,993	80,254	7.8

Trend estimates	**1992–2000**	**1980–2000**
overall	F	S
autumn		
January	-	++
spring		

For explanation of tables and figure see page 35

The population of Common Eider utilizing the North Sea waters adjacent to the Wadden Sea and the Wadden Sea habitats themselves numbers 850,000-1,200,000 birds and is decreasing (Wetlands International, 2002; Desholm *et al.* 2002). They mainly breed in the Baltic area; as of 1996, some 11,500 pairs breed in the Wadden Sea habitats, most of them in The Netherlands (Rasmussen *et al.*, 2000).

Common Eider from the Baltic breeding grounds may move as early as late May and June into the Wadden Sea area for their moult and numbers increase until August; they are distributed mainly in the central parts of the Wadden Sea. Numbers remain stable during autumn with some males leaving the Wadden Sea area but females and juveniles still immigrating. Wintering Common Eider reach a peak during January, with large proportions in the Dutch Wadden Sea. During February and March most Eiders leave for inner Danish waters and onwards to the Baltic during March and April (Swennen *et al.*, 1989; Meltofte *et al.*, 1994; Scheiffarth and Frank, 2005, this volume).

Counting results of Eider ducks based on ground counts are insufficient for population estimates or trends since many birds are missed. Internationally coordinated aerial counts in the entire Wadden Sea area exist for the winter period. During the moulting period aerial counts are also carried out, however, so far not in The Netherlands.

In winter, aerial counts showed an increase until

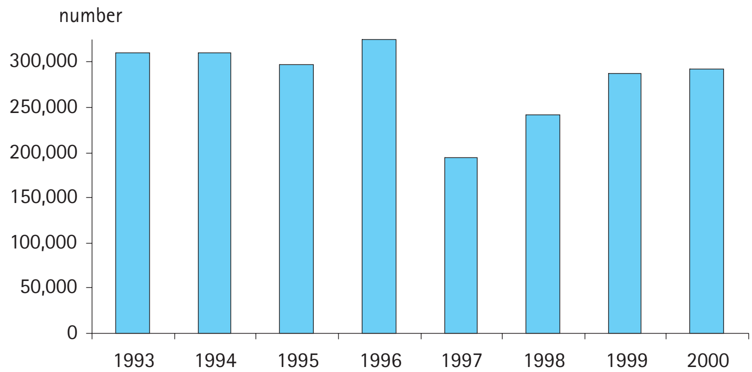


Figure 4.19: Eider – Results of aerial counts in winter (Jan / Feb); data compiled by G. Scheiffarth.

1996, followed by a drop due to the second cold winter 1997 and a foot shortage (Scheiffarth and Frank, 2005, this volume). The peak in 1996 was 325,800 birds; data of complete counts during the last decade only exists for 1987 and 1991, with 271,200 and 308,600 counted birds respectively. While those numbers seem to indicate a positive trend for 1980-2000 in the Wadden Sea areas, the lower numbers since 1996 and most recently after 2000 seem to eventually follow the decline of the larger flyway population (Desholm *et al.*, 2002).

Moulting populations in the German and the Danish Wadden Sea involved 170,000–230,000 individuals in the last two decades. Numbers have decreased from 1989 onwards (Desholm *et al.*, 2002), with a steep decline since 1994 in the major moulting area, the North-Friesian Wadden Sea and subsequent distribution shifts towards more western parts (Scheiffarth and Frank, 2005, this volume).

Ground counting results in spring are generally low but always peak with 70,000-80,000 counted birds during the international synchronous counts of March, April and May. Only one count between 1980-1991 yielded higher numbers, some 118,500 counted during May 1989. Also, in June and July, maximum numbers of 67,000 and 77,000 birds, respectively, have been reached during ground counts. In autumn, ground counts from August to December are around 70,000 birds, with a peak registered in October 1994 with 95,500 counted birds.

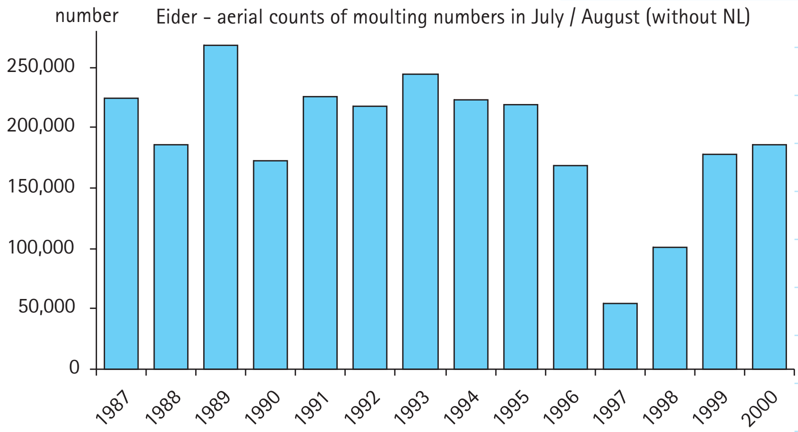
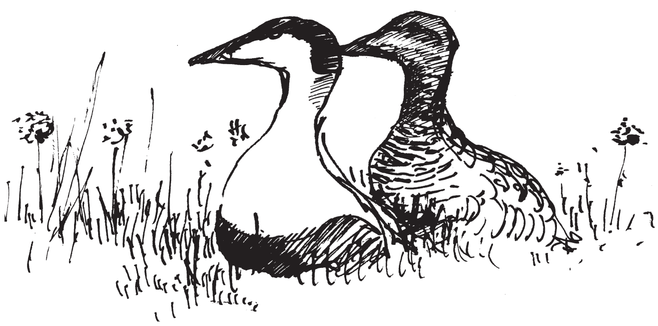


Figure 4.20: Eider – Results of aerial counts during moult (July/ August) in Denmark, Schleswig-Holstein and Niedersachsen (Germany). No data from Schleswig-Holstein in 1997 and 1998; data compiled by G. Scheiffarth.

Conclusion

After a peak in 1996, winter numbers of Common Eider seem to be lower, and in the winter 1999/2000 and subsequent winters large numbers of Common Eiders died due to a lack of profitably harvestable mussels or cockles (Camphuysen *et al.* 2002; Scheiffarth 2001). The Common Eider is not only sensitive to fluctuations in the total stock of shellfish but also, because of its foraging ecology, to food quality (Nehls, 2001); conflicts with fisheries are apparent (Scheiffarth and Frank, 2005, this volume). Moulting numbers have also decreased since 1989.

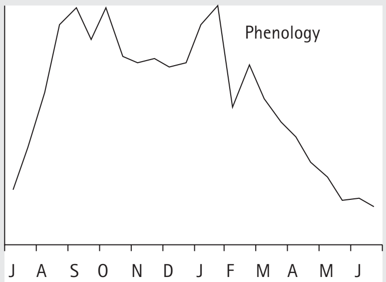
While ground counts may yield valuable information about numbers and distribution in the backwaters of the islands, aerial counts are indispensable to estimate total numbers and trends.



4.12 Eurasian Oystercatcher

Haematopus ostralegus

04500 DK: Strandskade D: Austernfischer NL: Scholekster



Subspecies / population: Breeding or wintering or core non-breeding range	Estimate	1% level	Trend
Europe, NW Africa	1,020,000	10,200	INC

(source: Wetlands International, 2002)

	1980-1991	1992-2000 arithm. mean of 3 max results		Flyway population
	estimated	counted	estimated	%
summer	103,000	100,078	152,965	15.0
autumn	**739,000**	389,444	574,517	56.3
winter	593,000	443,433	**581,904**	57.0
spring	481,000	204,204	319,069	31.3

Trend estimates	1992-2000	1980-2000
overall	--	-
autumn	-/--	
January	-	F
spring	-	

For explanation of tables and figure see page 35

The population of Oystercatchers migrating and wintering in coastal West Europe and North and West Africa is estimated at 1,020,000 and increasing (Wetlands International, 2002).

Oystercatchers use the Wadden Sea in large numbers throughout the year. Breeding bird numbers have increased from 1991 (37,156 pairs) to 1996 (46,360 pairs) (Rasmussen *et al.*, 2000), yet recent numbers indicate a levelling off or even a decrease (Dijksen *et al.*, in prep.).

After the breeding season, Oystercatchers from all over Northwest Europe migrate into the Wadden Sea and up to 50% of the flyway population winters here. Numbers reach peaks sometimes already in August but may stay high until January. In cold winters a part of the population moves west and southwards within the Wadden Sea, sometimes leaving for Great Britain or France. However, winter movements are less pronounced than for other species. After January, numbers gradually decrease while birds migrate through and leave towards their breeding grounds.

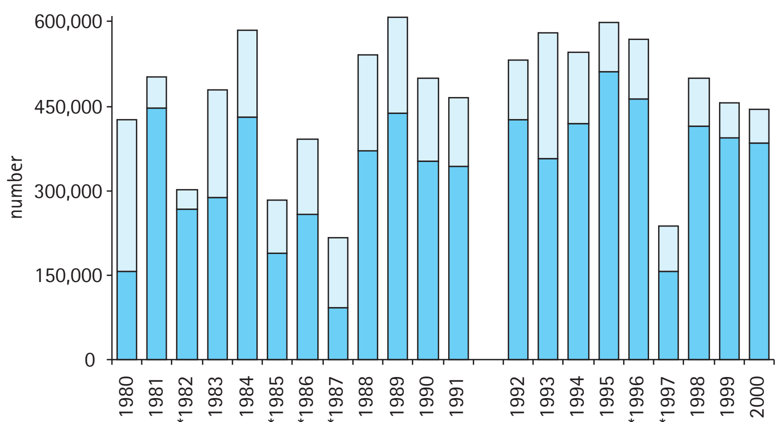


Figure 4.19: Estimated numbers of Oystercatcher in January (blue = counted, light blue = imputed).

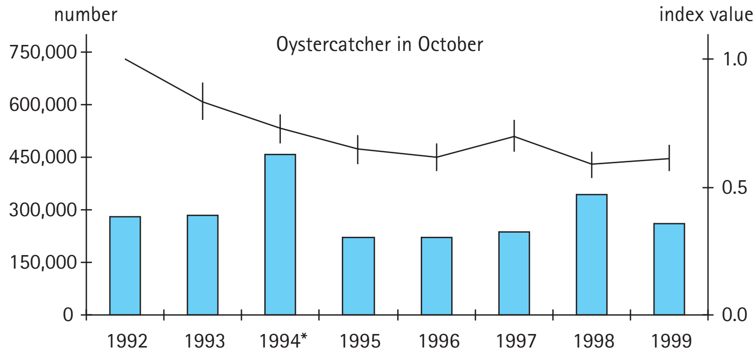


Figure 4.20: Oystercatcher - Counted numbers (bars) and index values (lines) in October.

Trend parameters in January 1992-2000 indicate a "decrease" (cold winters excluded). However, in January 1995, the highest number ever was counted with 511,400 individuals (597,900 estimated). The numbers 1980-2000 fluctuate, but suggest a slight, but not significant increase.

During the synchronous count in August 1996, 415,000 Oystercatchers were counted (430,000 estimated birds). However, results of imputed data suggest that numbers higher than 600,000 are reached in several autumn and winter months. Overall, those numbers do not reach the autumn migration numbers of the previous decade, when, for example, 660,000 Oystercatchers were counted during November 1980 (738,600) (note that Nov. 1980 counts include aerial counts in Niedersachsen). In each month between August and November 1992-2000 trend parameters indicated a "decrease" or a "substantial decrease".

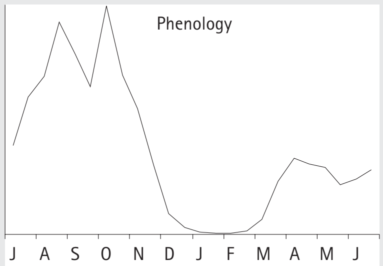
Conclusion

Within the Wadden Sea, a decrease of Oystercatchers is observed in all migratory periods. Similarly, declines are reported for Germany (Blew *et al*., 2005) and The Netherlands (van Roomen *et al*., 2004). In contrast to this, the flyway population of some 1,020,000 birds seems to be increasing (Wetlands International, 2002). Questions are, whether the trend in the Wadden Sea is more recent than the flyway population estimates or whether it is a regional phenomenon due to human interference (see Scheiffarth and Frank, 2005, this volume).

4.13 Pied Avocet

Recurvirosta avosetta

04560 **DK: Klyde** **D: Säbelschnäbler** **NL: Kluut**



Subspecies / population: Breeding or wintering or core non-breeding range	Estimate	1% level	Trend
W Europe (breeding)	73,000	730	STA

(source: Wetlands International, 2002)

	1980-1991	1992-2000 arithm. mean of 3 max results		Flyway population
	estimated	counted	estimated	%
summer	16,600	13,244	20,638	28.3
autumn	**44,600**	34,012	**46,358**	63.5
winter *	1,810	4,129	4,935	6.8
spring	18,000	12,287	16,170	22.2

* High numbers in winter are from December counts

Trend estimates	1992-2000	1980-2000
overall	--	S
autumn	--	
January		
spring	S/-	

For explanation of tables and figure see page 35

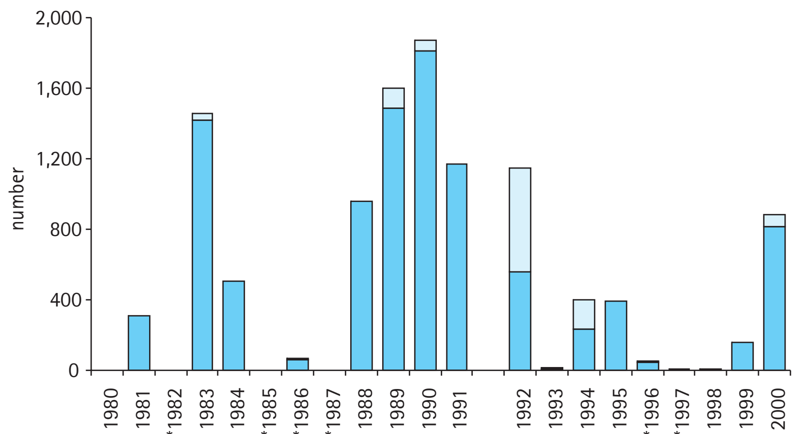
The population of Avocet migrating and wintering along the Atlantic coast including Northwest Africa is estimated at 73,000 and stable (Wetlands International, 2002).

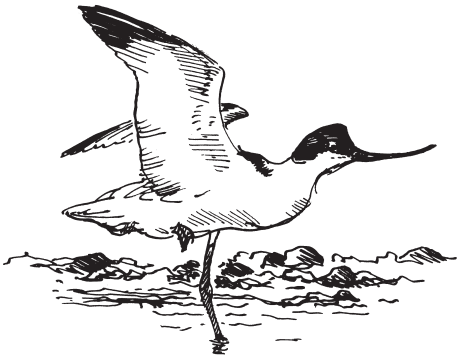
Avocets have a large breeding population in the Wadden Sea, numbering 10,617 pairs in 1996 (Rasmussen *et al.*, 2000). At the end of the breeding season, more birds move into the Wadden Sea habitats with increasing numbers up to October. From October on, birds leave the Wadden Sea almost entirely over the winter; in January, only up to 800 individuals may still be counted in The Netherlands. In March they start coming into the Wadden Sea again, but numbers stay below 20,000 until the breeding season starts.

For Avocet, the trends in winter are of no value.

Peak numbers rise from August (32,100 estimated birds in 1994) to October (52,200 estimated in 1994). Large proportions of these birds are found in Niedersachsen. Trend parameters for 1992-1999 in September and November indicate a "substantial decrease", in August and October a "decrease". Compared to the period 1980-1991, those numbers seem to be on the same level (Meltofte *et al.*, 1994).

Figure 4.21: Estimated numbers of Avocet in January (blue = counted, light blue = imputed).





Numbers in April and May are generally below 10,000 counted individuals; however, during the synchronous counts peaks are recorded with 17,900 counted birds in April 2000 (20,900 estimated) and 12,200 birds counted in May 1995 (14,600 estimated). The trend estimate for April is "stable", whereas for May it is a "decrease". Compared to the previous period, numbers in April 2000 are higher than any before, whereas in May recent numbers are lower.

Conclusion

During autumn, the main staging period for Avocet in the Wadden Sea, numbers are decreasing. A decline is also reported for Germany, less pronounced in spring (Blew *et al.*, 2005). In the Dutch Wadden Sea, however, overall numbers seem to be stable (van Roomen *et al.*, 2004). During spring migration, more Avocets seem to be present in the Wadden Sea in April now, suggesting an earlier migration peak than in the years before. The long term trend, however, seems to be stable, and thus in line with the flyway population estimates.

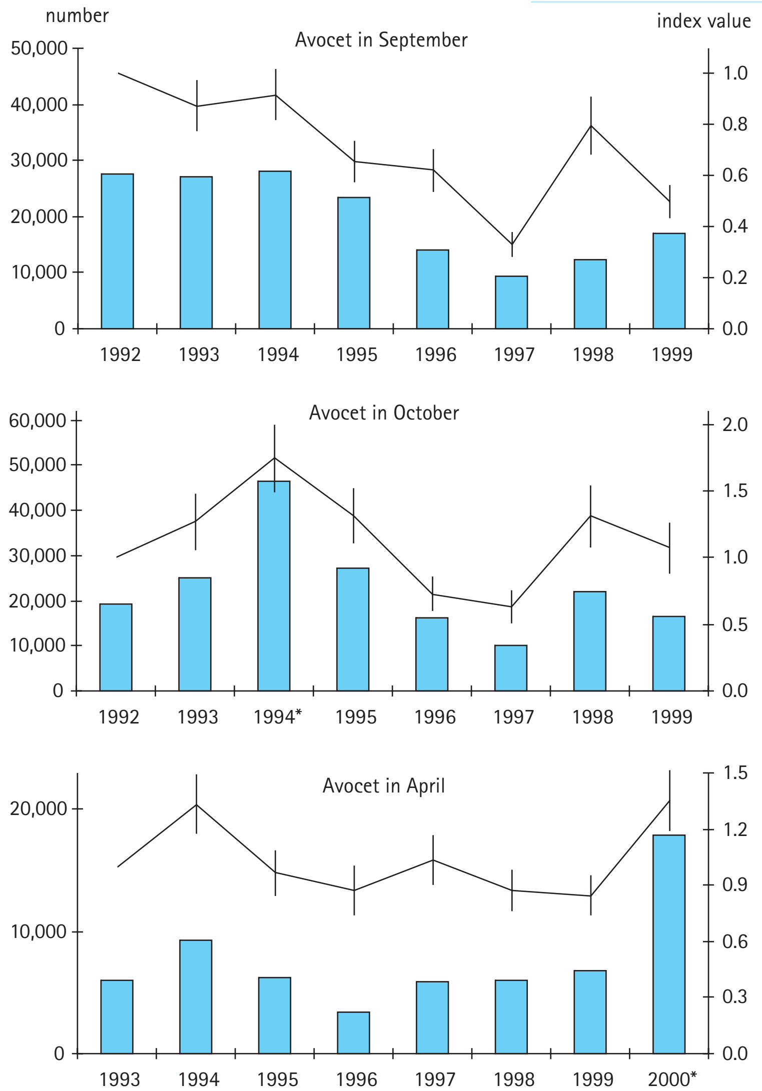
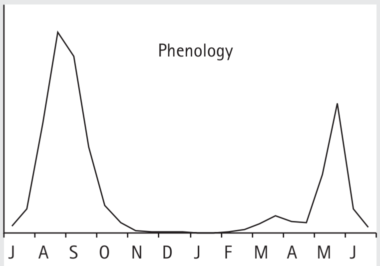


Figure 4.22: Avocet – Counted numbers (bars) and index values (lines) in September, October and April.

4.14 Great Ringed Plover

Charadrius hiaticula

04700 **DK: Stor Præstekrave** **D: Sandregenpfeifer** **NL: Bontbekplevier**



Subspecies / population: Breeding or wintering or core non-breeding range	Estimate	1% level	Trend
*hiaticula**: Europe, N Africa (non-breeding)	73,000	730	INC
tundrae: SW Asia, E&S Africa (non-breeding)	145,000 - 280,000	2,100	---
psammodroma: W&S Africa (non-breeding)	190,000	1,900	DEC?

* Population that winters in the Wadden Sea area

(source: Wetlands International, 2002)

	1980-1991	1992-2000 arithm. mean of 3 max results		Flyway population
	estimated	counted	estimated	%
summer	1,790	2,220	2,777	1.5
autumn	**14,100**	21,805	**32,909**	17.3
winter	201	433	594	0.3
spring	13,800	14,280	15,540	4.7

Trend estimates	1992-2000	1980-2000
overall	+ (n.s.)	+
autumn	F/+	
January		
spring	F	

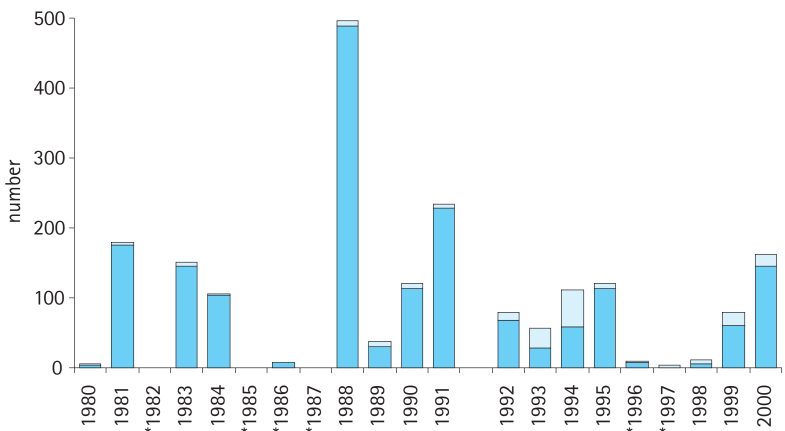
For explanation of tables and figure see page 35

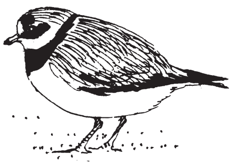
Great Ringed Plover occur in the Wadden Sea in three distinct populations (Wetlands International, 2002). Of the *hiaticula* population (73,000), currently some 1,400 pairs breed in the Wadden Sea (Rasmussen *et al*., 2000). At the end of the breeding season those individuals leave for the wintering areas whereas birds of the *tundrae* (145,000-280,000 breeding in Northeast Europe and Russia) and *psammodroma* (190,000 breeding in Northeast Canada, Greenland, Iceland and the Faeroes) populations pass through in August and September. Even in mild winters, very few birds stay in the Wadden Sea. Numbers start to increase in March represented by the *hiaticula* birds. In May, large numbers of *tundrae* (and probably *psammodroma)* birds move through (Meltofte *et al*., 1994; Stroud *et al*., 2004). Large proportions of these numbers are found in the Schleswig-Holstein Wadden Sea along the Friedrichskoog peninsula.

January numbers of Ringed Plovers are not very indicative because almost all birds leave the Wadden Sea.

The synchronous count in August 1996 yielded 27,300 counted birds (28,600 imputed); imputed

Figure 4.23: Estimated numbers of Ringed Plover in January (blue = counted, light blue = imputed).





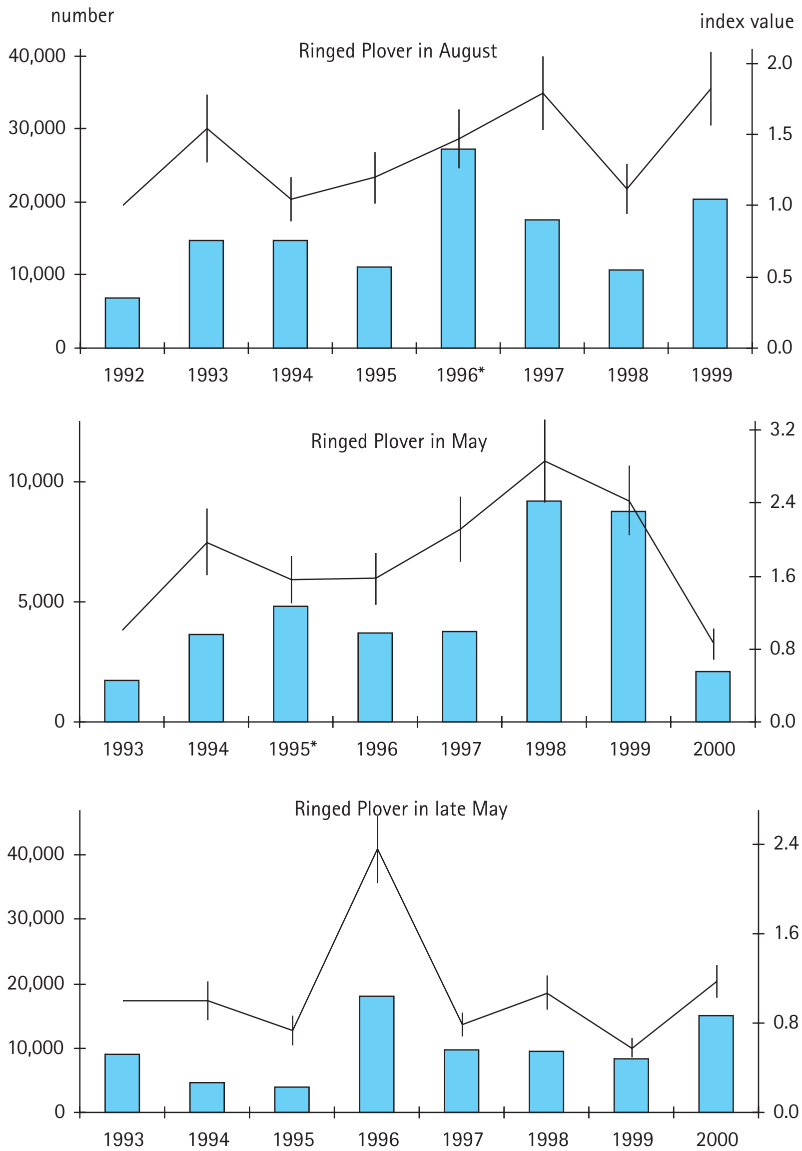


Figure 4.24: Ringed Plover – Counted numbers (bars) and index values (lines) in August, early and late May.

numbers were even higher in 1997 and 1999. Those numbers far exceed the results of the previous decade (10,000-14,000 estimated birds in August and September counts) (Meltofte *et al.*, 1994). Trend parameters for 1992-1999 indicate an "increase" in August, while September numbers do not show a significant trend.

The March and April numbers stay below 2,000 birds. Also, the synchronous count in early May 1995 did not pick up the peak of migration. Looking at the numbers in late May (no synchronous counts), two counts with 18,000 (1996) and 15,000 (2000) counted birds exist. Trend estimates for both May periods are not significant due to the fluctuating numbers. Compared to the preceding period, results have somewhat increased.

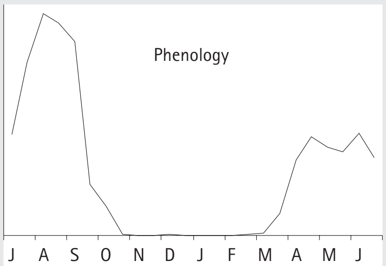
Conclusion

A moderate increase of Great Ringed Plover numbers, both short- and long-term, is suggested for the autumn migration period, while no clear results exist for the spring season. In the long term (1980-2000), an increase – at least for August – is also observed. For Germany, fluctuating numbers are observed for August and September, whereas for May, a slight increase exists (Blew *et al.*, 2005); numbers in the Dutch Wadden Sea are fluctuating (van Roomen *et al.*, 2004). Compared to the potential flyway population numbers migrating through the Wadden Sea, all recorded numbers represent only a very small fraction.

4.15 Kentish Plover

Charadrius alexandrinus

04770 **DK: Hvidbrystet Præstekrave D: Seeregenpfeifer NL: Strandplevier**



Subspecies / population: Breeding or wintering or core non-breeding range	**Estimate**	**1% level**	**Trend**
E Atlantic, W Mediterranean	62,000-70,000	660	DEC

(source: Wetlands International, 2002)

	1980-1991	1992-2000 arithm. mean of 3 max results		Flyway population
	estimated	**counted**	**estimated**	**%**
summer	342	240	434	0.7
autumn	**812**	477	**704**	1.1
winter	7	1	1	0.0
spring	391	214	358	0.5

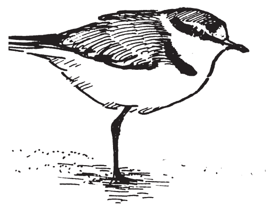
Trend estimates	1992-2000	1980-2000
overall	F	(S)
autumn	F	
January		
spring	F	

For explanation of tables and figure see page 35

The breeding population of Kentish Plovers in the Wadden Sea remains on a low level at around 520 pairs. This is still only 50% of the breeding birds present in the 1970s; however, between 1991 and 1996 the decrease was rather low (Rasmussen *et al.*, 2000). The flyway population of Kentish Plover wintering in Southwest Europe and Northwest African is estimated at 62,000-70,000 birds and decreasing (Wetlands International, 2002).

Birds from the breeding population appear at the roosting sites after June and reach peak numbers in August with large proportions present in Schleswig-Holstein, but very low numbers in Denmark. Birds leave the Wadden Sea during September and are absent from November to beginning of March. Most birds of the breeding population move into the Wadden Sea in April again.

Numbers during their peak period in August fluctuate at a low level and data is insufficient to support a trend estimate. Overall, counted numbers did not change compared to the last



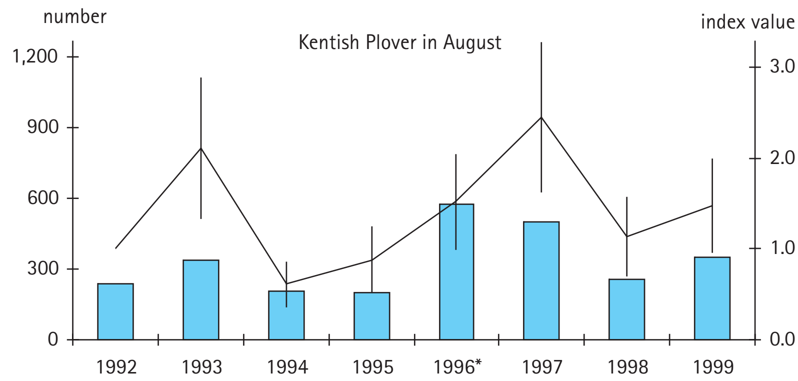


Figure 4.25: Kentish Plover – Counted numbers (bars) and index values (lines) in August.

decade, however, the maximum counts of 580 individuals in August 1996 or 300 in September 1992 are well below 800 counted birds in September 1988. Counts in spring do not reach the numbers of the breeding individuals, even though breeding and roosting habitats are fairly closely related (Koffijberg *et al.*, 2003).

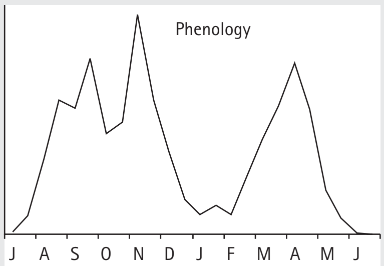
Conclusion

The Kentish Plovers counted in the Wadden Sea represent a fraction of the decreasing flyway population. Within the Wadden Sea no clear trend can be detected; and the same is true for Germany (Blew *et al.*, 2005).

4.16 Eurasian Golden Plover

Pluvialis apricaria

04850 DK: Hjejle D: Goldregenpfeifer NL: Goudplevier



Subspecies / population: Breeding or wintering or core non-breeding range	**Estimate**	**1% level**	**Trend**
apricaria: NW Europe (non-breeding)	69,000	650	DEC
*altifrons**: Ireland, W Britain, France, Iberia, NW Africa (non-breeding)	930,000	9,300	DEC

*Population that winters in the Wadden Sea area

(source: Wetlands International, 2002)

	1980–1991	**1992–2000** arithm. mean of 3 max results		**Flyway population**
	estimated	**counted**	**estimated**	**%**
summer	310	1,739	2,622	0.3
autumn	**168,000**	101,924	**153,315**	16.5
winter *	29,600	52,059	71,243	7.7
spring	80,100	77,918	108,031	11.6

* High numbers in winter are from December counts

Trend estimates	**1992–2000**	**1980–2000**
overall	- (n.s.)	-
autumn	--	
January		++ (n.s.)
spring	+/-	

For explanation of tables and figure see page 35

The Golden Plover population wintering in Western Europe south to Northwest Africa numbers at about 2 million individuals (Wetlands International, 2002). This includes the rather small and decreasing population (69,000) of the nominate subspecies (*P. a. apricaria*), with a breeding range from Great Britain to the Baltic States. Only one of the *P. a. altifrons* populations of estimated 645,000-954,000 birds, breeding in North Norway and West Russia and wintering in West and South Continental Europe down to Northwest Africa, migrates in considerable numbers through the Wadden Sea area. Another *P. a. altifrons* population (930,000 individuals) breeds on Iceland and the Faeroes. It migrates via Ireland and West Britain to France, the Iberian peninsula and NW Africa, and seems not to use the international Wadden Sea.

Most of the Golden Plover migrate inland (Koffijberg *et al.*, 2003; Hötker, 2004), thus only a small fraction of the population is counted in Wadden Sea habitats (see Chapters 2.2. and 3.1). Numbers start to increase in August, building up until October/November. Depending on the weather,

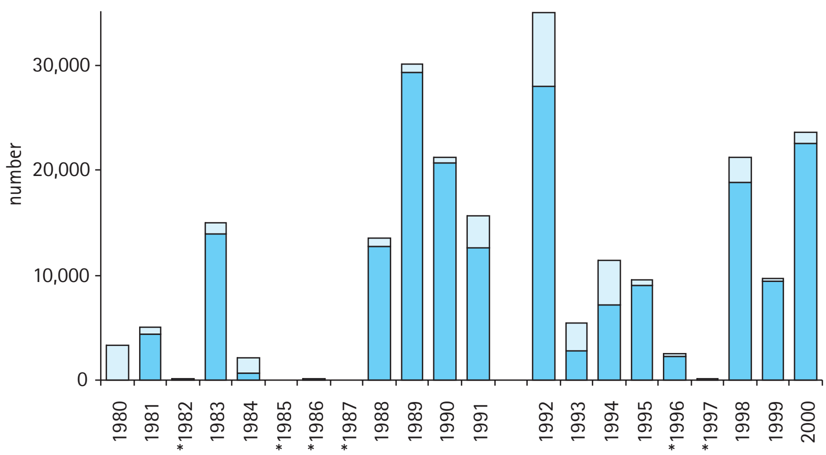


Figure 4.26: Estimated numbers of Golden Plover in January (blue = counted, light blue = imputed).

numbers decrease until January; winter numbers are low and vary depending on the severity of winter weather. The main migration period in the Wadden Sea during spring takes place in April.

While in cold winters almost all birds leave the Wadden Sea areas, for counts in mild winters January numbers are still at 35,000 estimated birds (27,900 counted) and are comparable to mild winter counts of the previous decade. Trend calculations for January 1992-2000 data are hampered by various factors (weather, habitat availability) and show no significant trend, the trend 1980-2000 suggests an increase, but is not significant.

While special synchronous Golden Plover counts – including inland areas – indicate maximum numbers in October (*e.g.* Flore *et al.*, 1994; Rasmussen, 1994; Jukema *et al.*, 2001; Hötker, 2004), peak numbers in the Wadden Sea are found in November (129,900 counted, 147,700 estimated birds at synchronous count in 1994). Many of these results include high imputed numbers, potentially indicating that Golden Plovers use different sites in different years. For November the trend estimate is a "decrease", and for October even a "substantial decrease". Autumn numbers stay well below those of the period 1980-1991 when September and October counts yielded between 60,000-80,000 and in November 1987 a total of 165,000 birds was counted (Meltofte *et al.*, 1994).

In spring, numbers peak in late March (118,700 counted, 175,300 estimated in March 1998) and early April (80,300 counted, 98,400 estimated birds in April 2000) and decrease from then on (maximum of 20,800 birds counted, 21,900 estimated in early May 1995). In March, birds are distributed evenly across the four regions, by the middle of May most birds have left the Wadden Sea. For March, the trend estimate is a "substantial increase", however, this is largely influenced by the very high March 1998 count. For April, the trend estimate is a "decrease", for May even a "substantial decrease". The March 1998 count is the highest count ever for Golden Plover in spring, whereas April numbers are comparable to the previous decade (35,000 and 50,000 birds counted), for May, all earlier counts in 1980-1991 are above 35,000 counted birds, with a maximum in early May 1991 of 78,100 counted birds (80,100 estimated).

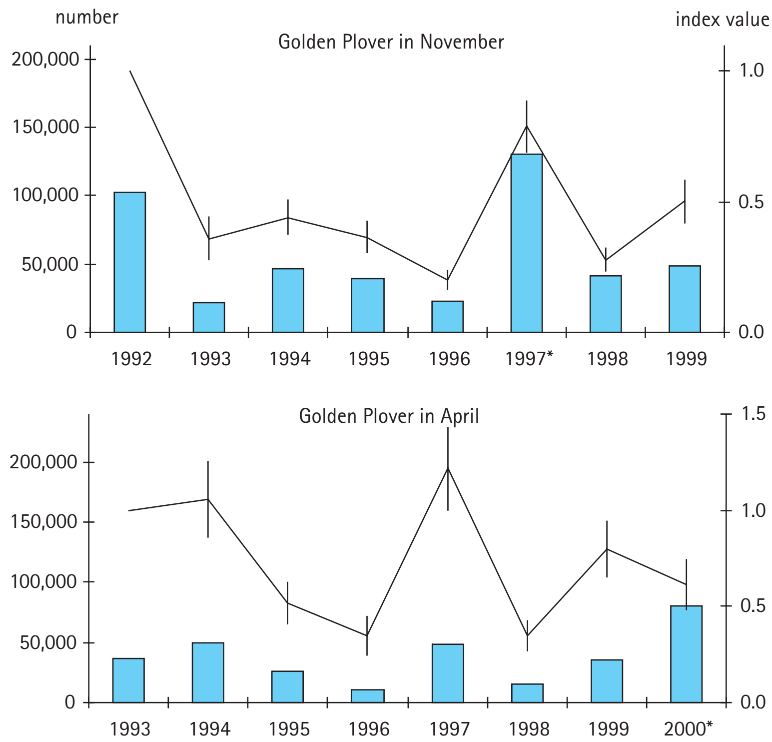


Figure 4.27: Golden Plover – Counted numbers (bars) and index values (lines) in November, and April.

Conclusion

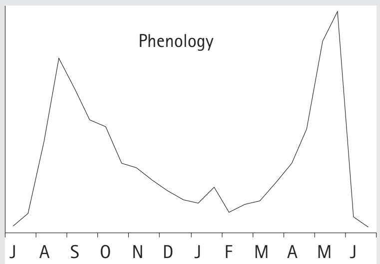
Trend estimates of Golden Plover in the Wadden Sea area for most peak months are decreases, resulting in an overall but not significant decrease for 1992-2000. However, the high March 1998 count on the one hand and the lower numbers in all other months compared to the former decade on the other may indicate a habitat shift of the migrating Golden Plovers. For Schleswig-Holstein, slight decreases are stated for autumn, winter and spring numbers (Blew *et al.*, 2005); in the Dutch Wadden Sea, numbers fluctuate (van Roomen *et al.*, 2004).

In contrast, the internationally coordinated Golden Plover count during October 2003 yielded close to 935,000 Golden Plovers in Northern Europe, suggesting an increase in overall numbers; however, most of those individuals were counted outside the Wadden Sea habitats (Hötker, 2004).

4.17 Grey Plover

Pluvialis squatarola

04860 DK: Strandhjejle D: Kiebitzregenpfeifer NL: Zilverplevier



Subspecies / population: Breeding or wintering or core non-breeding range	Estimate	1% level	Trend
E Atlantic (non-breeding)	247,000	2,500	INC

(source: Wetlands International, 2002)

	1980–1991	1992–2000 arithm. mean of 3 max results		Flyway population
	estimated	counted	estimated	%
summer	9,920	6,540	9,721	3.9
autumn	74,400	71,493	87,110	34.8
winter	20,800	35,257	45,136	18.1
spring	**140,000**	88,033	**137,810**	42.6

Trend estimates	1992–2000	1980–2000
overall	--	s
autumn	--	
January	F	++
spring	--	

For explanation of tables and figure see page 35

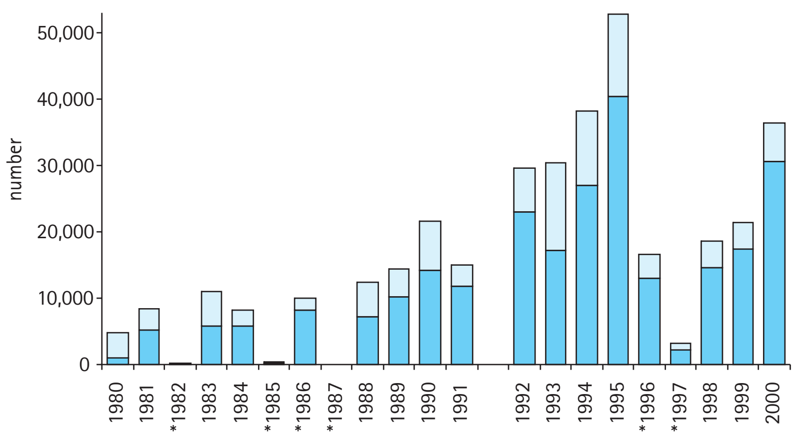
The East Atlantic flyway population of Grey Plover is estimated at about 247,000 individuals (Wetlands International, 2002) and has considerably increased during the last two decades.

Birds come into the Wadden Sea in August and peak in September when juveniles have arrived. They leave the Wadden Sea to a large extent in mild winters and almost completely during cold winters. Beginning in March, birds immigrate into the Wadden Sea area and numbers build up until late May (Meltofte *et al.*, 1994).

The January numbers for 1992-2000 are considerably higher than those of the previous decade. At the end of the period of mild winters peak counted numbers were of 40,300 birds (52,900 estimated) in January 1995. During the following cold winters, January numbers dropped considerably, however, they increased again during the mild winters 1998-2000. Due to those fluctuating numbers no trend for January 1992-2000 could be calculated, but the January trend 1980-2000 is a substantial increase.

The numbers in August reach a peak of 85,300 counted, 88,600 estimated Grey Plovers in 1996; although the high estimate of August 1992 should be taken with some caution. Trend estimates

Figure 4.28: Estimated numbers of Grey Plover in January (blue = counted, light blue = imputed).



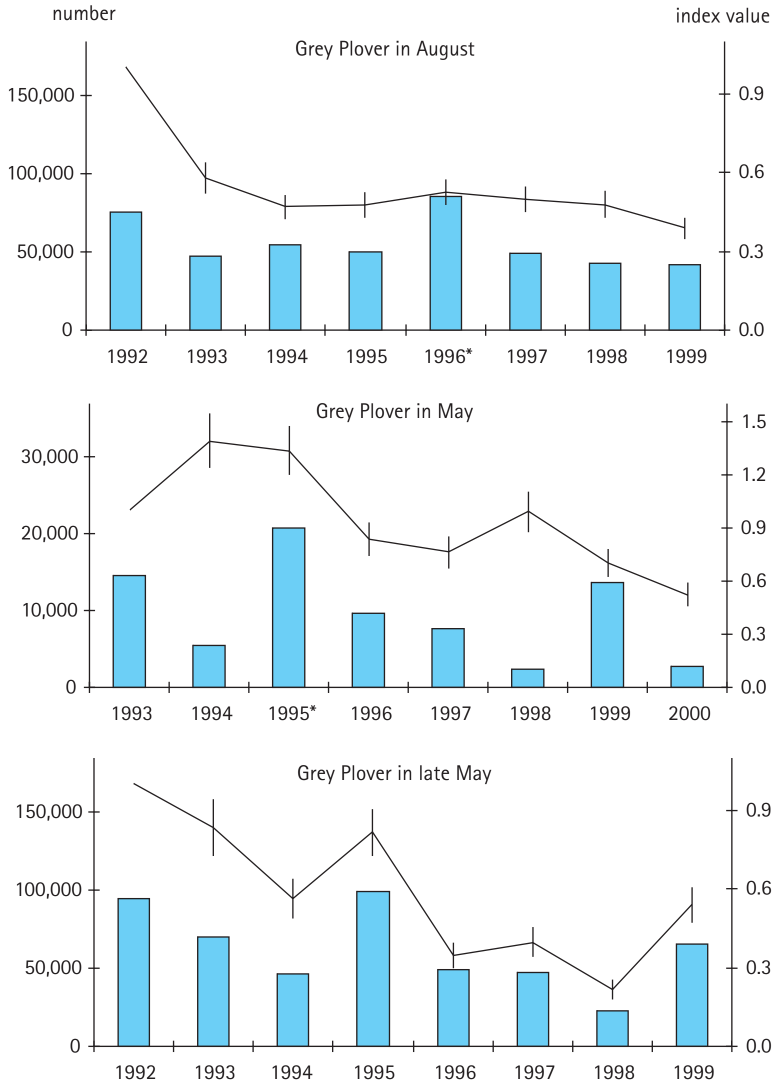


Figure 4.29: Grey Plover – Counted numbers (bars) and index values (lines) in August, May and late May.

for both August and September are "substantial decreases". Compared to the previous decade, however, numbers are generally higher.

In spring, numbers build up from March (36,400 estimated in 1994) to May (92,000 counted, 114,200 estimated birds in 1995). Whereas in March and April peak numbers are higher than in the previous decade (Meltofte *et al.*, 1994), peak numbers in May do not reach the 129,600 counted birds of mid-May 1990 (139,700 estimated) (Meltofte *et al.*, 1994). Late May counts (no international synchronous count included), however, include three counts during 1992-2000 with more than 140,000 birds estimated. Trend estimates 1992-2000 for April and May periods are all "substantial decreases", while in March numbers fluctuate.

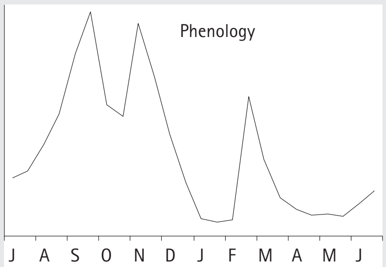
Conclusion

With the exception of the fluctuating January numbers, trend estimates 1992-2000 indicate "substantial decreases" in all peak months, which are April, May, August and September. In the long term, Grey Plover in the Wadden Sea increased up to 1992/1993, but show considerable decreases from then on. This is substantiated by data from Germany, showing decreasing trend patterns for all seasons (Blew *et al.*, 2005). In The Netherlands, stable numbers are reported for the last decade (van Roomen *et al.*, 2004). On the contrary, Denmark reports increasing numbers of Grey Plovers in all seasons (Laursen and Frikke, in prep.), yet the proportion of Grey Plovers in Denmark during the international counts has always been rather small.

4.18 Northern Lapwing

Vanellus vanellus

04930 **DK: Vibe** **D: Kiebitz** **NL: Kievit**



Subspecies / population: Breeding or wintering or core non-breeding range		1% level	Trend
Europe (breeding)	2,800,000 - 4,000,000	20,000	DEC

(source: Wetlands International, 2002)

	1980-1991	1992-2000 arithm. mean of 3 max results		Flyway population
	estimated	counted	estimated	%
summer	6,400	11,793	16,996	0.8
autumn	**132,000**	70,848	**112,852**	5.6
winter *	9,640	52,611	75,744	3.8
spring	23,200	18,837	29,399	1.5

* High numbers in winter are from December counts

Trend estimates	1992-2000	1980-2000
overall	- (n.s.)	S
autumn	-	
January		++ (n.s.)
spring	++	

For explanation of tables and figure see page 35

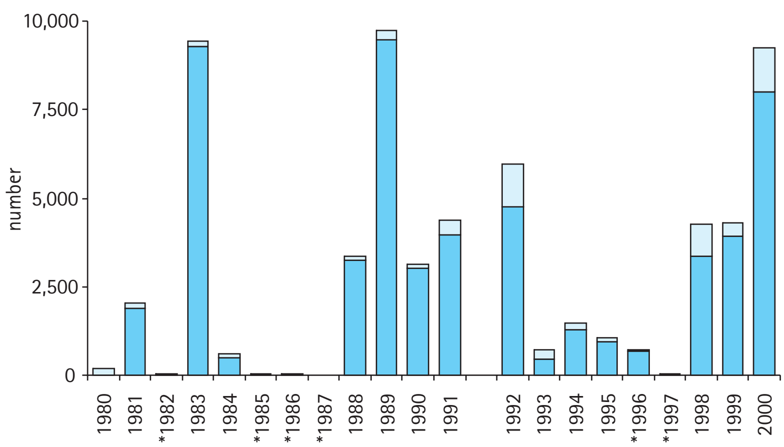
The Wadden Sea habitats are not a main staging area for Lapwing, which are generally found at inland habitats. Thus, Lapwing numbers in the Wadden Sea reflect the varying use of this habitat. From the estimated 2.8 to 4 million birds (Wetlands International, 2002), only a fraction are counted in Wadden Sea habitats. The breeding population in the Wadden Sea habitats is estimated at about 11,000 pairs (Rasmussen *et al*., 2000).

Lapwing numbers already rise in June and build up over the autumn months. In some years, many birds stay until December. In January, however, most birds have left the Wadden Sea area and start reappearing in late February.

Numbers in January are low, fluctuating considerably and counting results do not exceed 8,000 counted birds. But for example in December 1992, 67,600 Lapwings had still been counted. For January 1992-2000 a "substantial increase" is calculated, but of little value due to the low numbers.

During spring migration, numbers peak at 30,900 counted and 44,5000 estimated birds in March (1998) with the begin of the breeding

Figure 4.30: Estimated numbers of Lapwing in January (blue = counted, light blue = imputed).



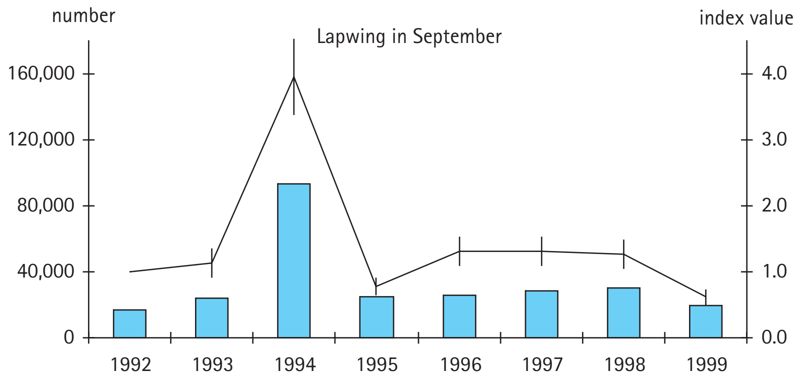


Figure 4.31: Lapwing - Counted numbers (bars) and index values (lines) in September.

season. During the breeding season it is difficult to achieve complete counts of Lapwings.

Numbers build up over the entire autumn period; a peak count of 93,400 counted birds (165,100 estimated) was reached in September 1994. Trend estimates of Lapwing in the autumn period (September to November) are all "decreasing". Compared to the previous decade, numbers – though fluctuating – are on an equal scale, however maximum counts with more than 100,000 counted individuals were reached in October 1984 and November 1987.

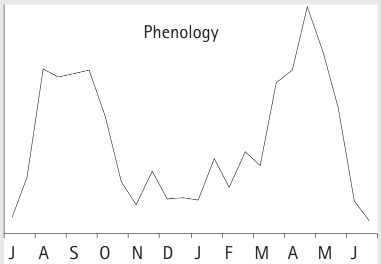
Conclusion

From the small fraction of the Lapwing population migrating through the Wadden Sea area, no population development trends can be derived. On migration more than 100,000 birds come through in autumn and more than 30,000 in spring. The overall trend is an insignificant decrease, owing to the autumn trend. Both, Germany and The Netherlands report fluctuating numbers (van Roomen *et al.*, 2004, Blew *et al.*, 2005).

4.19 Red Knot

Calidris canutus

04960 **DK: Islandsk Ryle** **D: Knutt** **NL: Kanoetstrandloper**



Subspecies / population: Breeding or wintering or core non-breeding range	**Estimate**	**1% level**	**Trend**
canutus: Central Siberia (breeding)	340,000	3,400	DEC
*islandica**: Greenland, High Arctic Canada (breeding)	450,000	4,500	DEC

*Population that winters in the Wadden Sea area

(source: Wetlands International, 2002)

	1980-1991	**1992-2000** arithm. mean of 3 max results		**Flyway population**
	estimated	**counted**	**estimated**	**%**
summer	22,800	30,786	43,949	9.8
autumn	352,000	215,599	334,118	74.2
winter *	101,000	147,422	160,232	35.6
spring	**433,000**	201,779	**338,500**	75.2

* High numbers in winter are from February counts

Trend estimates	**1992-2000**	**1980-2000**
overall	--	-
autumn	--	
January	++	++ (n.s.)
spring	F/--	

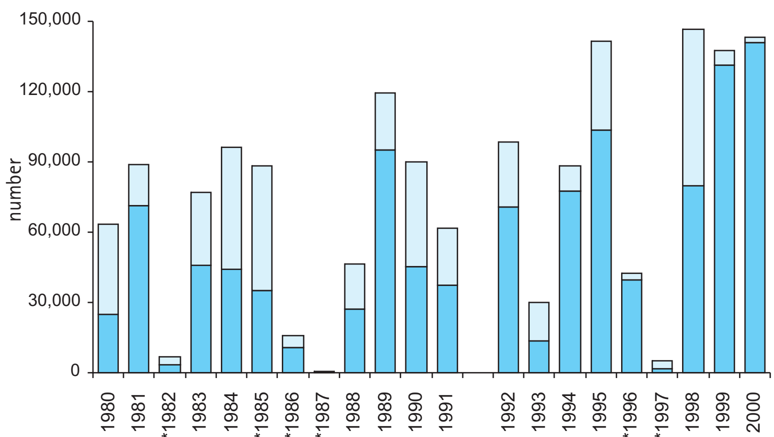
For explanation of tables and figure see page 35

Two populations of Knot visit the Wadden Sea. *Calidris c. canutus* breeds in Siberia, numbers about 340,000 and winters in West Africa; their trend is decreasing. Some 450,000 *C. c. islandica* breed in Canada and Greenland and spend the winter in Western Europe, mainly the Wadden Sea, Britain and Ireland; an increasing trend is reported up to 2000, after that decreases have been observed (Wetlands International, 2002).

Already in July, numbers from both populations build up in the Wadden Sea, peaking in August or September when juveniles also immigrate. The *canutus* birds leave the Wadden Sea in September after a short stay for fuelling their reserves. The *islandica* birds stay for primary moult during autumn and in varying numbers over winter. In spring, immigration of *islandica* birds may start as early as February, with numbers building up until April. Most birds leave by the beginning of May. At that time the *canutus* birds move in and depart to the Northeast at the end of May to early June (Meltofte *et al.*, 1994). During the migration periods the vast majority of the counted birds are registered in Schleswig-Holstein; only during winter are similar proportions recorded in Schleswig-Holstein and The Netherlands.

The January numbers of Knots – representing the *islandica* subspecies - vary considerably between years. In January 1999 and 2000, maximum

Figure 4.32: Estimated numbers of Knot in January (blue = counted, light blue = imputed).



numbers of 131,500 and 140,700 counted birds were reached (137,600 and 143,00 estimated), but, for example, in February 1993 a total of 171,000 Knots were counted. For the period 1992-2000 the January trend estimate, excluding the cold winters, indicates a "substantial increase"; the trend for 1980-2000 is an insignificant increase.

The counts in August and September indicate "substantial decreases" for the period 1992-2000. In August 1992-1999, numbers were in many cases higher than in the previous decade (only one count in August 1982 with 135,800 counted and 189,500 estimated). In September, all counts later than 1996 resulted in lower numbers than September counts from the previous decade; even the highest estimate (202,800 counted, 308,000 estimated in 1994) did not reach the numbers of 347,900 or 351,900 estimated birds in September 1980 and 1981, respectively. However, the 1980 and 1981 numbers still included aerial counts in Germany. October results include very high imputed numbers and do not qualify for a trend estimate.

The counts in April indicate a "substantial decrease" whereas May numbers are insufficient to calculate a trend. Numbers in both months stay lower than in the previous decade (April and May 1992-2000 maxima close to 225,000 counted birds, imputed numbers are unreasonably high, compared to a maximum count of 382,000 counted and 432,000 estimated birds in early May 1987).

Conclusion

Since two populations of Knots migrate through the Wadden Sea area, their population developments / trends might overlap and thus are hard to analyze. The increase in January most probably regards the *islandica* birds. This flyway population also increased up to 2000, from then on a decrease seems to take place (Wetlands International, 2002). For the other migration months, "substantial decreases" are calculated. While it is hard to allocate those to either of the two subspecies, at least the September and the April decreases most probably regard the *islandica* birds. The overall decreasing numbers in the international Wadden Sea are substantiated by data from Schleswig-Holstein in Germany, holding the largest proportions of those numbers; here, a considerable decrease has been observed during autumn, a less pronounced decrease also in spring (Blew *et al.*, 2005). For the Dutch Wadden Sea, a decrease has been reported for the recent decade (van Roomen *et al.*, 2004).

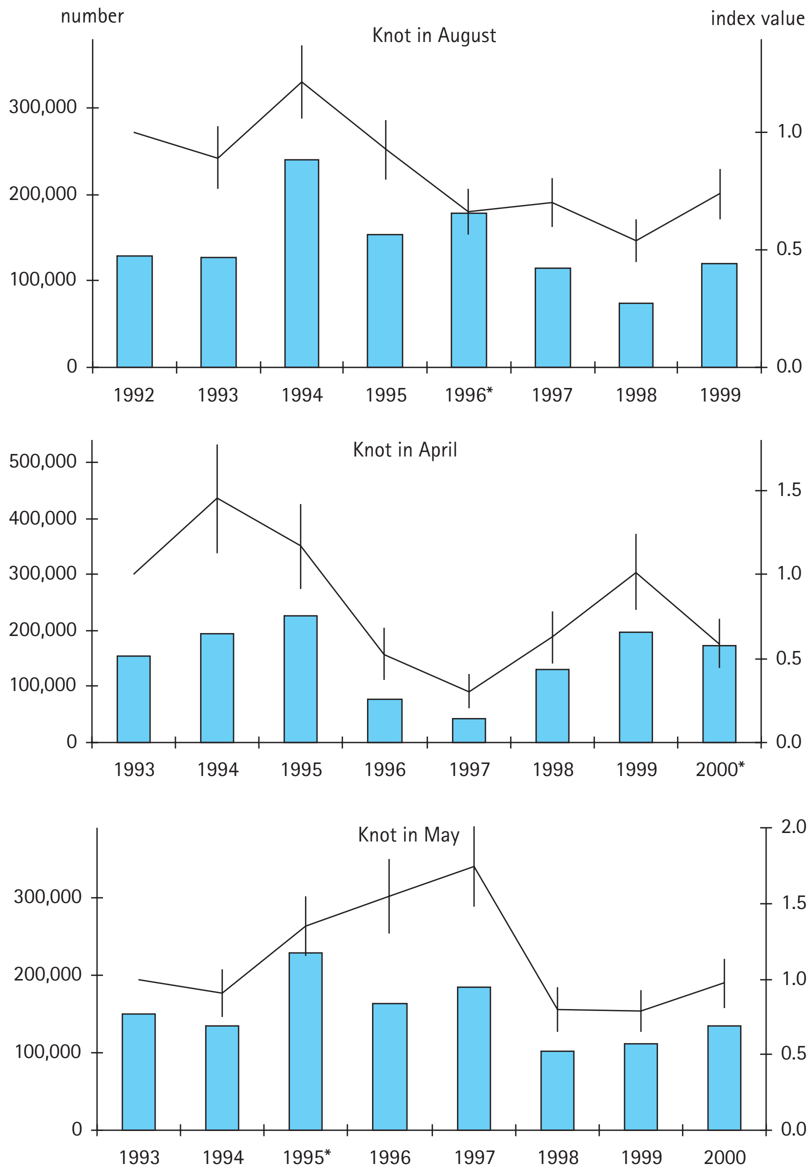
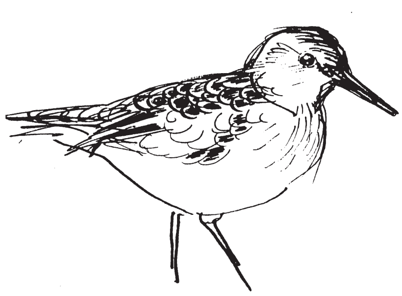


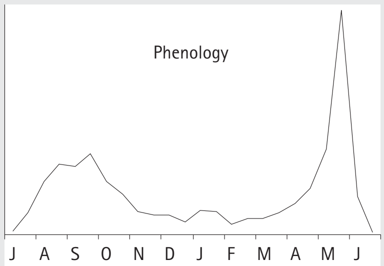
Figure 4.33: Knot - Counted numbers (bars) and index values (lines) in August, April and May.



4.20 Sanderling

Calidris alba

04970 DK: Sandløber D: Sanderling NL: Drieteenstrandloper



Subspecies / population: Breeding or wintering or core non-breeding range	Estimate	1% level	Trend
E Atlantic, W&S Africa (non-breeding)	123,000	1,200	STA/INC

(source: Wetlands International, 2002)

	1980-1991	1992-2000 arithm. mean of 3 max results		Flyway population
	estimated	counted	estimated	%
summer	1,830	2,109	3,429	2.9
autumn	**13,200**	11,811	20,347	17.0
winter	6,120	4,982	7,231	6.0
spring	20,200	25,657	**28,798**	12.3

Trend estimates	1992-2000	1980-2000
overall	- (n.s.)	+
autumn	F	
January	F	++ (n.s.)
spring	-	

For explanation of tables and figure see page 35

The population of Sanderling migrating and wintering along the Atlantic coast south to Africa is estimated at 123,000 with an unclear trend status (Wetlands International, 2002).

A large proportion of that population migrates through the Wadden Sea area, utilizing it mainly as a stopover on migration in spring and with lower numbers in autumn. Adults start to move in during July, and numbers build up including the juveniles in August. The birds stay through October. In winter, most birds have left the Northern part of the Wadden Sea, while some birds (up to 4,000) stay in the Dutch part of the Wadden Sea. The majority move on to more southern parts of West Europe and to West Africa. During spring, Sanderlings move through the Wadden Sea from March until early June, with peak numbers in the second half of May reaching 30,000 birds in recent years. Large proportions of those are counted in Schleswig-Holstein (Meltofte *et al.*, 1994).

The Sanderling is the only wader species considered in this report showing no difference in numbers between cold and mild winters. January numbers 1992-2000 suggest an increase, but due to high imputed numbers the trend is not significant. The long-term trend 1980-2000 is also an insignificant increase.

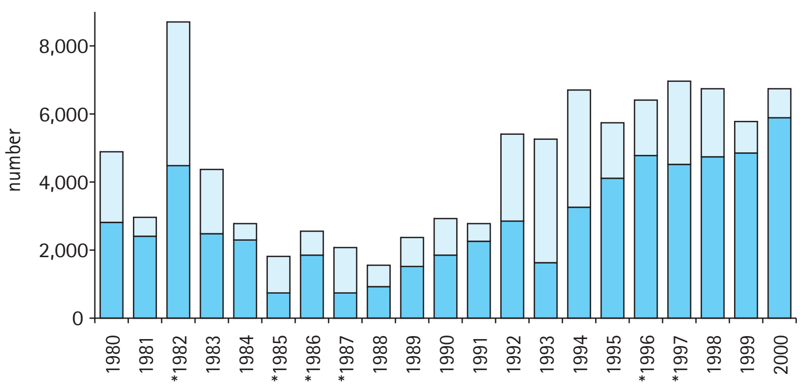


Figure 4.34: Estimated numbers of Sanderling in January (blue = counted, light blue = imputed).

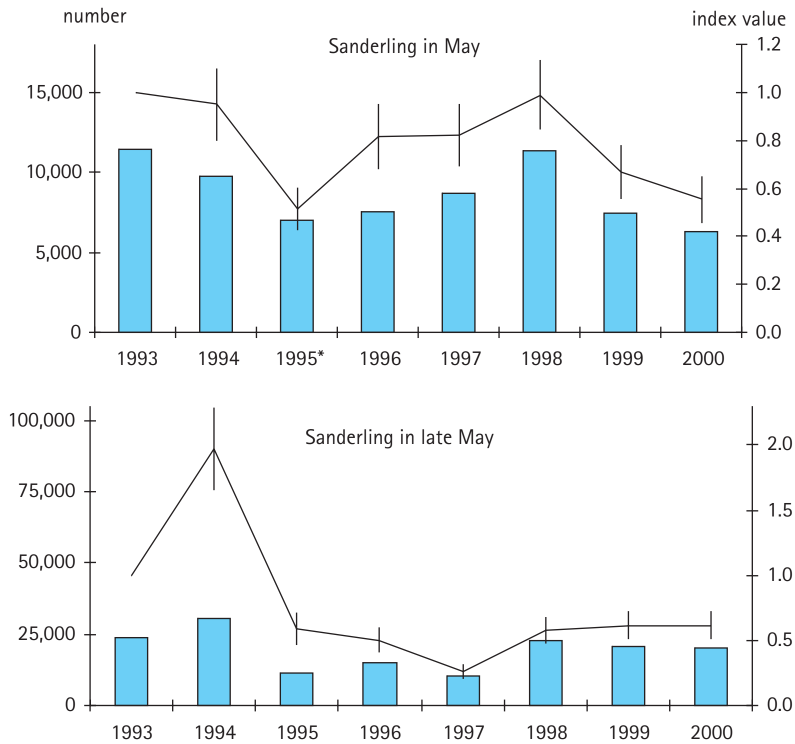


Figure 4.35: Sanderling - Counted numbers (bars) and index values (lines) in May and late May.

For the international synchronous counts in early May trend parameters show a "decrease". From 1998 on, extra effort had been invested for Sanderling counts in late May, leading to regularly high results and low imputed numbers. Together with late May counts from earlier years (no international synchronous count included), the trend estimate for the late May period indicates a stable situation. Since the late May counts before 1998 yielded fluctuating values and a high proportion of imputed data, the stable trend is not significant. All late May numbers are higher than the counts of 1980-1991.

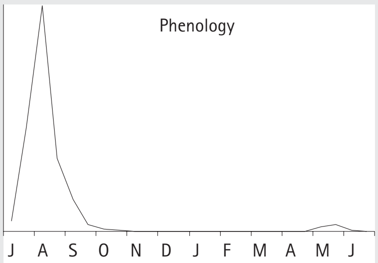
Conclusion

Due to the fluctuating numbers, the short migration peak and the difficulties of counting Sanderlings, existing results do not give a clear picture with regard to trend. In the Dutch Wadden Sea an increase of overall numbers has taken place (van Roomen *et al.*, 2004). In Schleswig-Holstein (Germany), a decrease from 1995 to 2002 in particular in the spring-tide counting areas has been observed during the peak migration in May; for this region, holding high Sanderling numbers within the Wadden Sea, this decrease might be explained by a distribution shift away from the sandy spring-tide counting areas (*e.g.* the island of Trischen, sandy beaches of western Eiderstedt) to other areas not included in the spring-tide counting scheme; the latter consist of muddy tidal flats influenced by brackish waters located at the Elbe and Eider estuaries (*e.g.* Dieksander Koog). Thus, for Schleswig-Holstein results from the combination of spring-tide counts with extra counts in late May at areas where Sanderlings occur show a smaller decrease. A regular extra yearly Sanderling count around 25 May (+/- 4 days) would improve monitoring of this species.

4.21 Curlew Sandpiper

Calidris ferruginea

05090 **DK: Krumnæbbet Ryle D: Sichelstrandläufer NL: Krombekstrandloper**



Subspecies / population: Breeding or wintering or core non-breeding range	Estimate	1% level	Trend

(source: Wetlands International, 2002)

	1980-1991	1992-2000 arithm. mean of 3 max results		Flyway population
	estimated	counted	estimated	%
summer	35	4,514	4,851	0.7
autumn	**6,680**	9,017	**10,717**	1.4
winter	0	0	0	0.0
spring	35	10	13	0.0

Trend estimates	1992-2000	1980-2000
overall	--	(+)
autumn	--	
January		
spring		

For explanation of tables and figure see page 35

The large breeding population of Curlew Sandpiper migrates on several different routes to the wintering areas. The flyway population moving through Western Europe numbers about 740,000 individuals with increasing tendency (Wetlands International, 2002). However, only a small fraction passes through the Wadden Sea during July and August on its way to West African wintering sites.

Curlew Sandpipers begin to move into the Wadden Sea already during July and peak in early August, quickly passing through. Among the waders, this is one of the earliest species on its way South; by September, almost all birds have left the area. Spring migration happens almost entirely outside the range of the Wadden Sea with only a few individuals registered in The Netherlands and Schleswig-Holstein, mostly at brackish tidal flats (Meltofte *et al.*, 1994; Zeiske, 1997).

Two peak counts of 12,200 counted individuals in August 1994 and 11,200 in August 1996 (13,500 and 11,400 estimated) are considerably higher than any count from the former decade, which never exceeded 2,200 birds (Meltofte *et al.*, 1994).

Curlew Sandpiper move through the Wadden Sea during a very short time interval. In 1992, 1993 and 1996 some 20,000-25,000 birds had

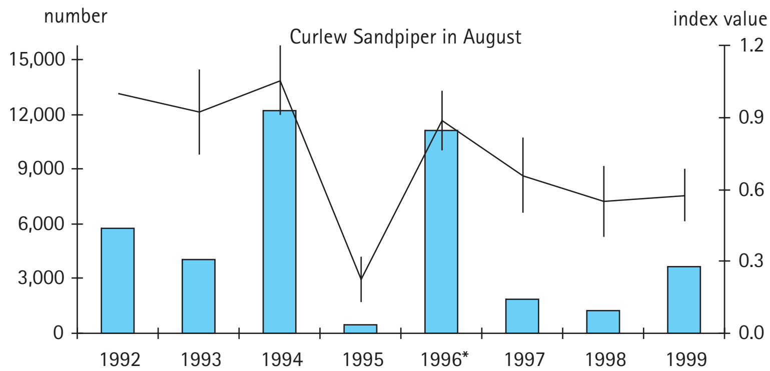


Figure 4.36: Curlew Sandpiper - Counted numbers (bars) and index values (lines) in August.

been counted in Schleswig-Holstein at one site alone (Dieksanderkoog Süd). Those 25,000 individuals had been estimated as representing 80% of the adult population moving through the area and they are assumed to be moulting adult males together with some unsuccessful breeding females (Zeiske, 1997). The international synchronous counts are carried out too late in August to pick up these moulting birds; also, the main staging site is not a spring-tide counting area. Therefore, a special count of this site plus the area of the Elbe estuary in Schleswig-Holstein is carried out during early August each year. Consequently, international August counts of this species vary and some are fairly low with considerable numbers imputed. The trend estimate for August indicates a substantial decrease, but should be taken with some caution.

Conclusion

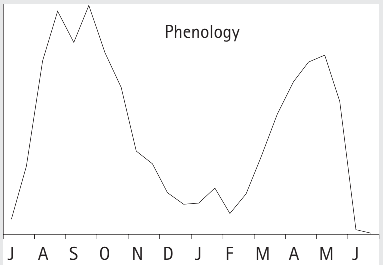
Due to their very short passage of the Wadden Sea area, Curlew Sandpiper data is insufficient to give a trend estimate. Also, the birds using the Wadden Sea as a stopover only represent a fraction of the flyway population.

4.22 Dunlin

Calidris alpina

05120

DK: Almindelik Ryle D: Alpenstrandläufer NL: Bonte Strandloper



Subspecies / population: Breeding or wintering or core non-breeding range	Estimate	1% level	Trend
alpina: W Europe (non-breeding)	1,330,000	13,000	STA
schinzii : Baltic (breeding)	3,600-4,700	40	DEC

(source: Wetlands International, 2002)

	1980-1991	1992-2000 arithm. mean of 3 max results		Flyway population
	estimated	counted	estimated	%
summer	8,920	123,229	186,810	14.4
autumn	**1,200,000**	814,509	**1,384,306**	106.5
winter	258,000	236,219	309,193	23.8
spring	1,120,000	794,205	906,511	69.7

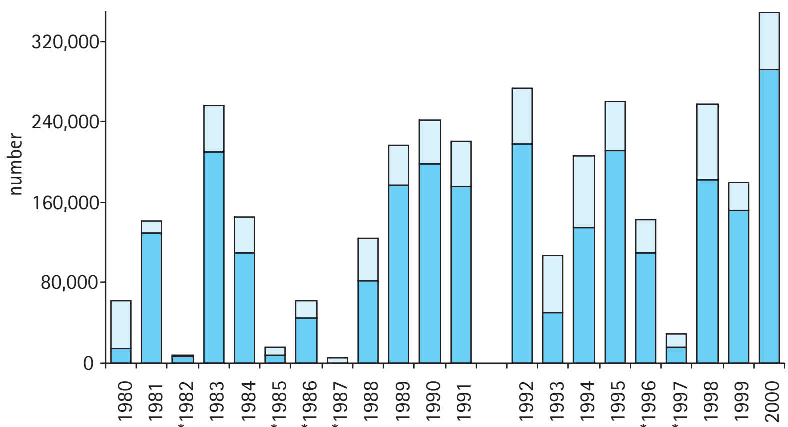
Trend estimates	1992-2000	1980-2000
overall	--	S
autumn	--	
January	++	++ (n.s.)
spring	-	

For explanation of tables and figure see page 35

Most of the Dunlins migrating through the Wadden Sea belong to the subspecies *Calidris a. alpina*; their population size is estimated at 1,330,000 birds and stable (Wetlands International, 2002). Most of the additional 1 million *schinzii* birds from different breeding grounds as well as 21,000-45,000 *arctica* birds move over the British isles, and only a few of those may be seen in the Wadden Sea area (Meltofte *et al.*, 1994). The Dunlin breeding population in the Wadden Sea area seems to be decreasing further, in 1996 the estimate is 39 pairs, most of which breed in Denmark (Rasmussen *et al.*, 2000).

While small numbers of Dunlin, probably of the Baltic *D. a. schinzii* breeding population, arrive in the Wadden Sea area as early as in late June, larger numbers of *alpina* adults immigrate into the area in July, followed by juveniles during August and early September (Meltofte *et al.*, 1994). After primary moult has finished, many Dunlins leave the Wadden Sea and numbers considerably drop down in October. However, considerable numbers stay over winter in the Wadden Sea area. Beginning in late February, more birds move into the Wadden Sea; this influx continues during March, April to May. Almost all birds depart by the end of May (late May counts are lower than early

Figure 4.37: Estimated numbers of Dunlin in January (blue = counted, light blue = imputed).



May counts) and only several hundreds stay over summer.

In mild winters, up to 291,700 counted birds (January 2000, 328,400 estimated) stay in the Wadden Sea habitats. While most numbers in the recent decade are on the same scale as in the previous decade, the peak count of 2000 had not been reached before. In cold winters numbers are much lower. The trend calculation for overall January numbers 1992-2000 results in a "substantial increase", while the long-term trend 1980-2000 gives an insignificant increase.

The maximum number of counted birds in autumn 1992-1999 was reached in August 1996 with 991,200 birds (1,020,800 estimated). While counted numbers in September 1992-1999 seem to be lower than in August, estimated numbers suggest that more than 1.2 million birds stay in the Wadden Sea during this month, thus practically the entire *alpina* population, and would be an increase compared to most numbers from the previous decade. For 1992-2000, the trend in August is a "decrease", and in September and October even a "substantial decrease".

In spring, numbers build up from March (630,300 counted, 801,000 estimated in March 1998) to early May (899,400 and 1,003,800 in 1995). The numbers for March and April are higher than in the previous decade, while the peak numbers in May 1992-2000 are comparable to the maximum of 1,120,000 counted birds in May 1990. The trend estimate is an "increase" in March, suggesting an earlier arrival of Dunlins; however, this increase is mainly due to the very high count in March 1998. A "decrease" in April and a "substantial decrease" in May indicate a negative trend for the main migration period, even though the calculated decrease in May might be influenced by the high synchronous count in May 1995.

Conclusion

During the main migration periods in spring and autumn, Dunlin numbers are decreasing, resulting in an overall decrease in the Wadden Sea. Whether this represents the trend of the flyway population or a shift in migration behavior should be further observed. While Dunlin had been decreasing in the UK, the numbers have been stable during the last 10 years (Austin *et al.*, 2003). Danish Wadden Sea data shows a permanent slight decrease since 1992 (Laursen and Frikke, in prep.), and in Germany decreases are reported for all seasons (Blew *et al.*, 2005). In contrast, in the Dutch Wadden Sea an increase is taking place (van Roomen *et al.*, 2004).

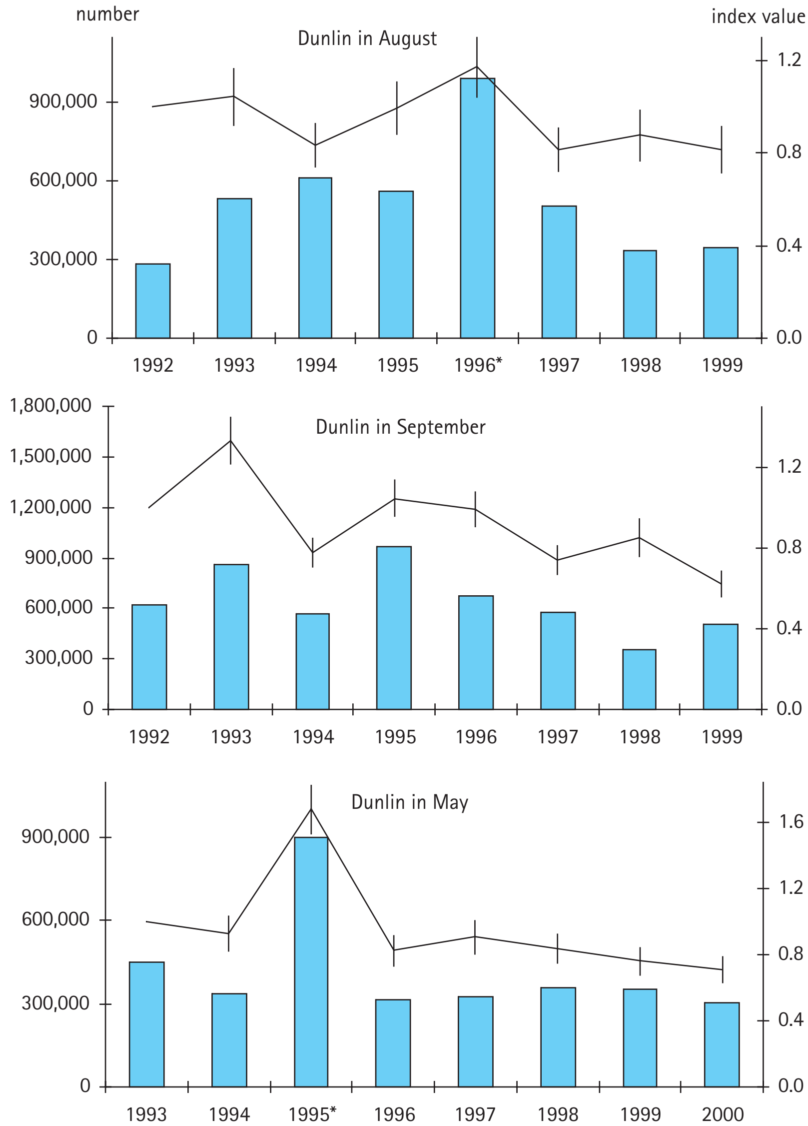
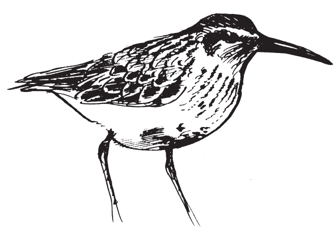


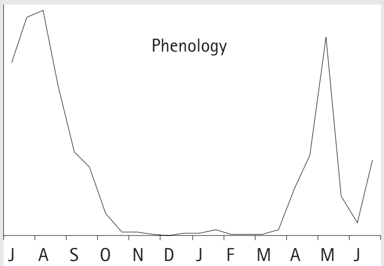
Figure 4.38: Dunlin – Counted numbers (bars) and index values (lines) in August, September and May.



4.23 Ruff

Philomachus pugnax

05170 DK: Brushane D: Kampfläufer NL: Kemphaan



Subspecies / population: Breeding or wintering or core non-breeding range	Estimate	1% level	Trend
W Africa (non-breeding)	2,200,000	20,000	DEC

(source: Wetlands International, 2002)

	1980-1991	1992-2000 arithm. mean of 3 max results		Flyway population
	estimated	counted	estimated	%
summer	274	3,018	4,758	0.2
autumn	**3,340**	3,378	**5,245**	0.3
winter	318	235	241	0.0
spring	19,800	2,798	3,880	0.2

Trend estimates	1992-2000	1980-2000
overall	F	(-)
autumn	F	
January		
spring	--	

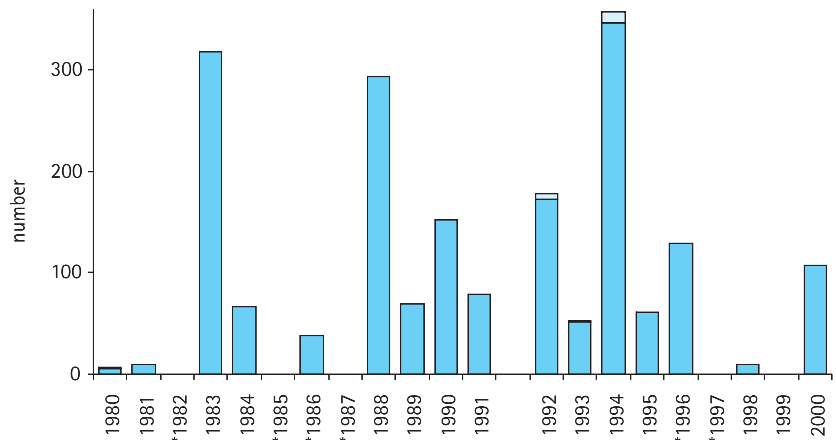
For explanation of tables and figure see page 35

The global population of Ruff wintering in Africa or in Southwest Asia is estimated at about 2.2 million birds and decreasing (Wetlands International, 2002). Only a fraction of these birds migrate through Western Europe (Meltofte *et al.*, 1994) and of those only some tens of thousands actually use Wadden Sea habitats during their stay. The numbers of Ruffs breeding in the Wadden Sea areas are low, and have decreased from 240 pairs in 1991 to 82 pairs in 1996 (Rasmussen *et al.*, 2000).

Immigration starts as early as late June and numbers peak in late July to early August and decrease from then on. By October most birds have left for their wintering grounds. During mild winters a few hundred birds stay in The Netherlands, in cold winters all birds leave.

Spring immigration starts in April and peaks in the first half of May. During most of the migration period considerably more than half of the birds are counted in Schleswig-Holstein, mainly in embanked areas with wetlands, marshes and meadows, sometimes also in salt marsh habitat.

Figure 4.39: Estimated numbers of Ruff in January (blue = counted, light blue = imputed).



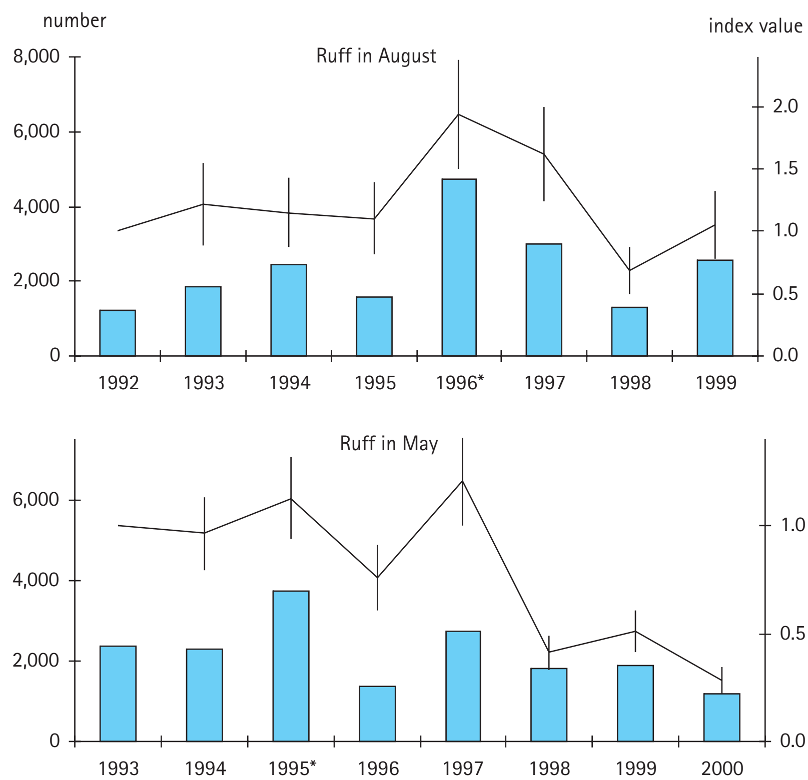


Figure 4.40: Ruff - Counted numbers (bars) and index values (lines) in August and May.

The highest counts are from August 1996 (4,700 counted, 6,500 estimated birds). Trend estimates for August cannot be given, because numbers fluctuate too much.

The peak May count in 1995 yielded 3,700 individuals (6,100 estimated), late May counts do not result in higher numbers. This is on the same scale as most May counts of the previous decade, however, in May 1989, 18,900 birds were counted, most of those in Denmark. The trend estimate for May is a "substantial decrease", however, fluctuating and low numbers may not be representative.

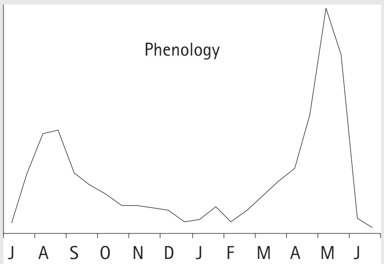
Conclusion

Ruff numbers and overall trend estimates are fluctuating; these varying numbers are most probaby related to varying habitat use and the weather conditions during migration. The number of 14,000 Ruff counted in Denmark (STC site Tøndermarsken) in May 1989 has not been reached in recent years (the maximum number at that STC site is some 3,000 birds in May 1994). Germany reports fluctuating numbers during migration (Blew *et al.*, 2005).

4.24 Bar-tailed Godwit

Limosa lapponica

05340 **DK: Lille Kobbersneppe D: Pfuhlschnepfe NL: Rosse Grutto**



Subspecies / population: Breeding or wintering or core non-breeding range	**Estimate**	**1% level**	**Trend**
*lapponica**: Coastal W Europe, NW Africa (non-breeding)	120,000	1,200	STA
taymyrensis: Coastal W & SW Africa (non-breeding)	520,000	5,200	DEC

* Population that winters in the Wadden Sea

(source: Wetlands International, 2002)

	1980-1991	**1992-2000** arithm. mean of 3 max results		**Flyway population**
	estimated	**counted**	**estimated**	**%**
summer	13,500	18,997	28,606	5.5
autumn	151,000	102,596	141,750	27.3
winter	43,000	57,892	68,320	13.1
spring	**341,000**	210,190	**273,312**	52.6

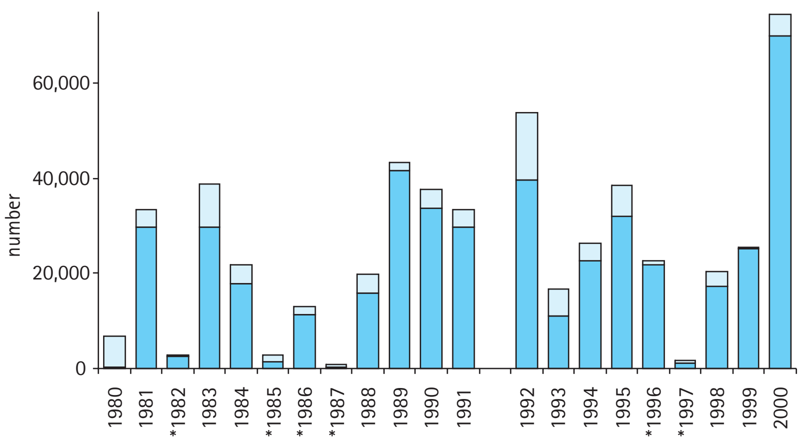
Trend estimates		
	1992-2000	**1980-2000**
overall	-	S
autumn	-	
January	+	++ (n.s.)
spring	--	

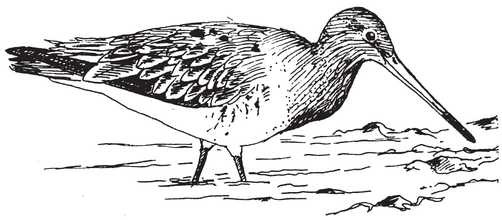
For explanation of tables and figure see page 35

Two populations of Bar-tailed Godwit migrate through the Wadden Sea area. The European population *Limosa l. lapponica* winters mainly in the Western part of the Wadden Sea and in Great Britain and breeds in Fennoscandia; it is estimated at some 120,000 birds and stable. The Afro-Siberian population *L. l. taymyrensis* (newly recognized as a subspecies), winters in West Africa and breeds in Siberia; it numbers some 520,000 birds and is decreasing (Wetlands International, 2002; Meltofte *et al.*, 1994). The migration patterns of these two populations overlap in the Wadden Sea, sometimes using only different locations in the same region. For example,. in the Sylt-Rømø Wadden Sea in Schleswig-Holstein, birds of the Afro-Siberian population stop over in May as well as in July/August on the mainland coast. In contrast, birds of the European population stay for three months in spring until May as well as from autumn to late winter mainly on the islands (*e.g.* Sylt) (Scheiffarth *et al.*, 2002).

Birds start moving into the Wadden Sea in late July and peaks are reached in August. During September and October numbers decrease continuously, when the *taymyrensis* birds leave to West Africa. Between 20,000-40,000 birds spend the winter in the Wadden Sea. In March, numbers begin to increase when the *lapponica* birds move

Figure 4.41: Estimated numbers of Bar-tailed Godwit in January (blue = counted, light blue = imputed).





back into the Wadden Sea. In May they are joined by the *taymyrensis* birds and peak numbers are reached with large proportions counted in The Netherlands and in Schleswig-Holstein.

Trend estimates for the January numbers 1992-2000 (excluding cold winters) indicate an "increase", representing the *lapponica* population. However, numbers fluctuate considerably and the high count in January 2000 (69,800 birds counted, 74,500 estimated) may influence this estimate. Most January numbers from 1992-2000 compare well to the numbers of the previous decade, the trend 1980-2000 is an insignificant increase.

Autumn migration peak numbers are reached in August (129,700 counted in August 1996, estimates up to some 250,000 birds in other months include high imputed numbers), and thus seem to be higher than in the previous decade. Trend estimates for August 1992-1999 indicate a "decrease".

Most May numbers range between 100,000-150,000 counted birds and are in general lower than the May counts of the previous decade (four counts with more than 240,000 counted birds). However, during the international synchronous count in May 1995 a total of 348,000 birds was counted (366,100 estimated). A look at Figure 4.42 suggests that this high number is not only a result of the counting effort, because this would have led to high imputed numbers in the counts in other years. More probably, the May 1995 count may have been particularly well timed during a short period, when the highest numbers of Bar-tailed Godwit were present. Late May results are generally lower. Trend estimates for May indicate a "substantial decrease". The latter – again – must be taken with some caution because the high May 1995 value may largely influence the results.

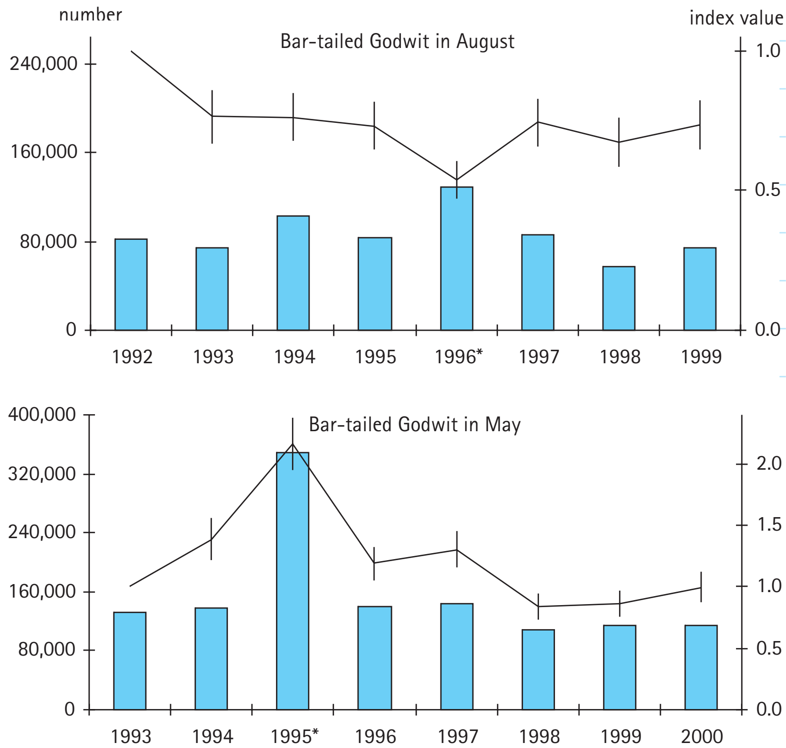


Figure 4.42: Bar-tailed Godwit - Counted numbers (bars) and index values (lines) in August and May.

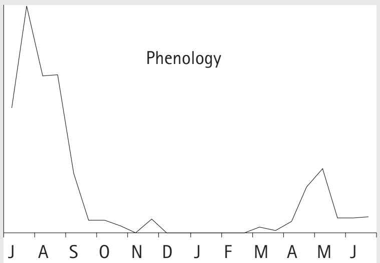
Conclusion

Bar-tailed Godwit migration through and utilization of the Wadden Sea is a complex phenomenon due to the two separate flyway populations. During the main migration periods, the overall trend estimates for 1992-2000 are negative, leading also to an overall decreasing trend; however, peak counts in this period are higher than those of the previous decade, suggesting a long-term increasing or stable situation. For Germany, the trend for this species is described as considerably decreasing in autumn and slightly decreasing in spring (Blew *et al.*, 2005). In the Dutch Wadden Sea an overall increase is taking place (van Roomen *et al.*, 2004) and Denmark reports stable numbers (Laursen and Frikke, in prep.).

4.25 Whimbrel

Numenius phaeopus

05380 DK: Lille Regnspove D: Regenbrachvogel NL: Regenwulp



Subspecies / population: Breeding or wintering or core non-breeding range	Estimate	1% level	Trend
NE Europe (breeding)	160,000 - 300,000	2,300	STA/INC

(source: Wetlands International, 2002)

	1980-1991	1992-2000 arithm. mean of 3 max results		Flyway population
	estimated	counted	estimated	%
summer	11	1,444	**2,124**	0.9
autumn	**631**	1,501	1,645	0.7
winter	1	15	15	0.0
spring	1,330	128	138	0.1

Trend estimates	1992-2000	1980-2000
overall	F	(+)
autumn	F	
January		
spring		

For explanation of tables and figure see page 35

Birds from a large breeding population from Fennoscandia, the Baltic States, Northwest Russia and Greenland (160,000-300,000, stable or increasing) pass through West Europe on a broad inland passage, some of which may stage in Wadden Sea sites (Wetlands International, 2002).

After the breeding season, Whimbrel move into the Wadden Sea as early as July, peaking during the second half of July and staying at a slightly lower level during August. By October they have left the Wadden Sea and return from their wintering range during the second half of April and early May in low numbers, soon leaving for their breeding grounds.

Maximum counted numbers in August are 1,680 counted birds during the synchronous count in 1996 (estimated 1,780). The high result of August 1999, with 4,400 estimated birds of which only 1,780 were counted, should not be over-interpreted. August numbers are high compared to the previous decade, when August numbers did not exceed 469 counted birds. The indices in August suggest an increase, however, largely influenced by high imputed numbers in 1998 and 1999 and not significant. Numbers in July reach almost the same level as in August. The high numbers in July 1998 and 1999 underline the possible positive trend from August, but July trend estimates are also not significant.

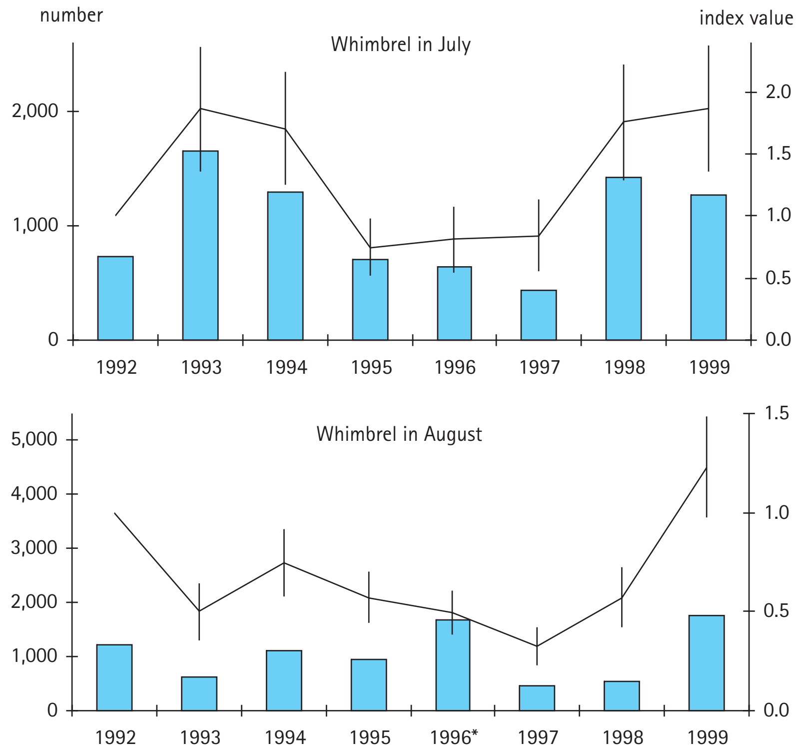


Figure 4.43: Whimbrel - Counted numbers (bars) and index values (lines) in July and August.

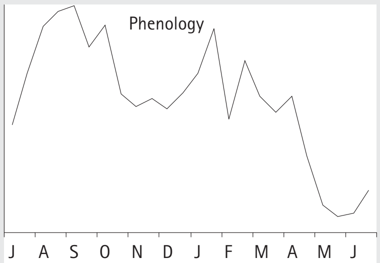
Conclusion

Clearly, Whimbrel numbers in the Wadden Sea are not indicative for population trends, since very small fractions of the flyway populations are actually present. In addition, identification of this species is not always sure and confusion with the Eurasian Curlew is possible (Meltofte *et al.*, 1994). However, for The Netherlands, a decrease is reported for the Wadden Sea and neighboring habitats during the recent decade (M. Engelmoer, written comm.); for Germany, decreasing numbers are registered for July/August (Blew *et al.*, 2005).

4.26 Eurasian Curlew

Numenius arquata

05410 DK: Stor Regnspove D: Großer Brachvogel NL: Wulp



Subspecies / population: Breeding or wintering or core non-breeding range	Estimate	1% level	Trend
W, Central & N Europe (breeding)	420,000	4,200	STA/INC

(source: Wetlands International, 2002)

	1980-1991	1992-2000 arithm. mean of 3 max results		Flyway population
	estimated	counted	estimated	%
summer	14,900	92,566	129,412	30.8
autumn	**227,000**	175,231	**279,315**	66.5
winter	**178,000**	202,071	241,766	57.6
spring	120,000	135,762	175,687	41.8

Trend estimates	1992-2000	1980-2000
overall	-	S
autumn	-	
January	F	++ (n.s.)
spring	-	

For explanation of tables and figure see page 35

The European Curlew population is estimated at about 420,000 birds and stable (Wetlands International, 2002). The breeding population in the Wadden Sea was about 630 pairs in 1996, most of them in The Netherlands and Niedersachsen (Rasmussen *et al.*, 2000).

Curlews start moving into the Wadden Sea shortly after the breeding season as early as late June, numbers peak in August and September. Numbers in the entire Wadden Sea stay fairly high throughout the winter while birds move west to Niedersachsen and The Netherlands. Numbers in the Wadden Sea habitats may vary because Curlew frequently move inland for feeding (*e.g.* Gloe, 1998, 1999) (see Chapters 2.2 and 3.1). By April and early May most of the birds have left the Wadden Sea for their breeding grounds.

January numbers depend on the severity of the winter. January trend parameters for the period 1992-2000 tend to be stable, however data is not sufficient to make this significant. Considering 1980-2000, January numbers have increased (not significant); the high numbers in 1989 and 1991 of 133,700 counted and 177,800 estimated birds were exceeded after 1992 by several counts above 150,000 and a peak count of 228,000 counted birds in 1995 (262,400 estimated).

Peak numbers in August are 217,600 counted birds during the synchronous count in 1996 (223,400 estimated, but 270,100 estimated in

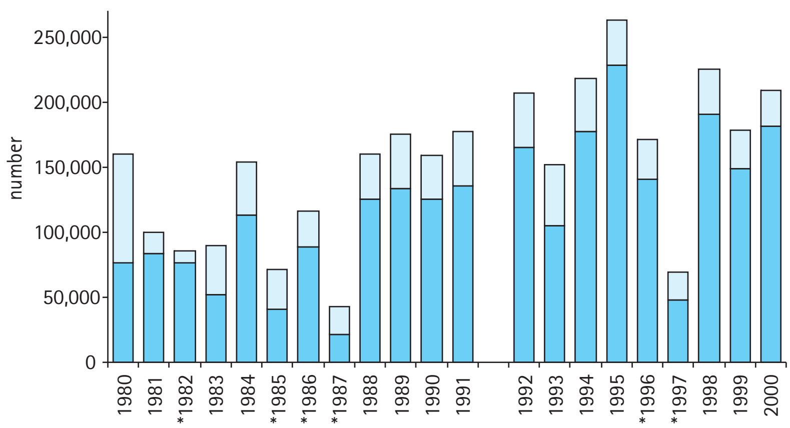
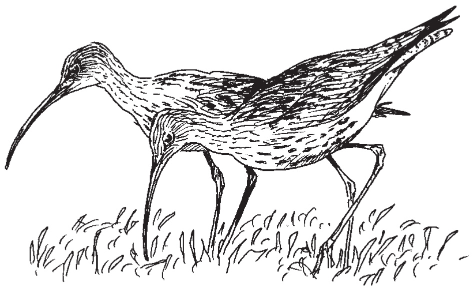


Figure 4.44: Estimated numbers of Curlew in January (blue = counted, light blue = imputed).



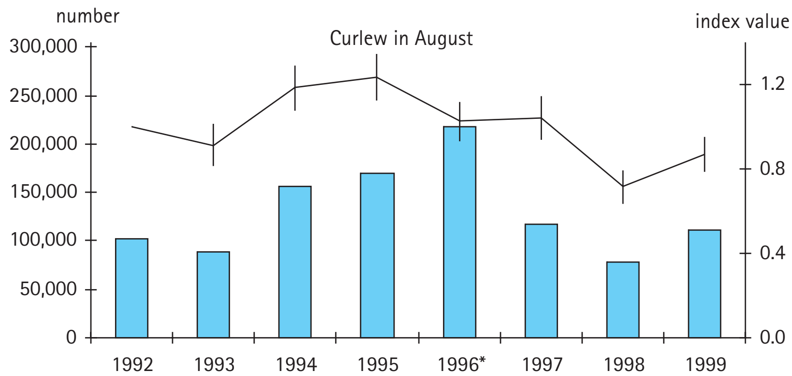


Figure 4.45: Curlew - Counted numbers (bars) and index values (lines) in August.

August 1995). In September, 207,800 birds were counted in 1995 (270,200 estimated). On the one hand, August and September results of 1992-2000 are higher than any count from the previous decade; on the other hand, trend parameters for both months in the period 1992-2000 both indicate a "decrease".

Trend parameters for March and April are "decreases", but numbers are in general higher than during the previous decade with maximum results reached during the synchronous counts in March 1998 with 139,300 counted (213,100 estimated) birds and in April 2000 with 159,400 counted (171,300 estimated). In May, the already lower numbers fluctuate too much for a significant trend estimate.

Conclusion

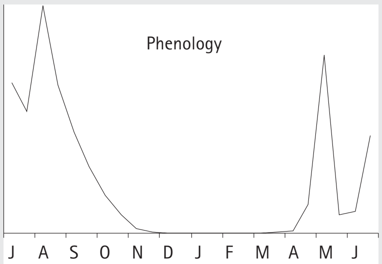
During 1992-2000, decreases are observed in autumn and spring migration, while January numbers fluctuate, resulting in an overall decreasing trend. For the long-term, stable or increasing situations exist for winter and other migration periods. For Germany, decreasing trends exist for all seasons, in particular from 1995 onwards (Blew *et al.*, 2005). For the Dutch Wadden Sea, the overall situation is described as stable (van Roomen *et al.*, 2004) and increasing numbers are reported for Denmark (Laursen and Frikke, in prep.).

See also special contribution on curlew in this volume (Laursen, 2005).

4.27 Spotted Redshank

Tringa erythropus

05450 **DK: Sortklire D: Dunkler Wasserläufer NL: Zwarte Ruiter**



Subspecies / population: Breeding or wintering or core non-breeding range	**Estimate**	**1% level**	**Trend**
Europe (breeding)	77,000 - 131,000	1,000	STA

(source: Wetlands International, 2002)

	1980-1991	**1992-2000** arithm. mean of 3 max results		**Flyway population**
	estimated	**counted**	**estimated**	**%**
summer	3,200	8,831	14,706	14.7
autumn	13,800	14,205	18,380	18.4
winter	32	88	90	0.1
spring	**15,200**	13,332	**18,814**	18.8

Trend estimates		
	1992-2000	**1980-2000**
overall	-	S
autumn	-	
January		
spring	--	

For explanation of tables and figure see page 35

The Spotted Redshank breeding population of North Scandinavia and NW Russia, wintering mainly in West Africa, is estimated at 77,000 to 131,000 birds and considered to be stable (Wetlands International, 2002).

Female birds already appear in late June in the Wadden Sea, followed by the males in July and the juveniles in July and August. Thus, overall numbers reach a peak in August. It is not sure whether June and July numbers are representative because of poor counting coverage during these months. Adult birds stay to moult at Wadden Sea sites and most of them leave for their winter quarters in September, however, some birds stay until mid-November (Meltofte *et al.*, 1994). After that until the first half of April almost no birds have been recorded in the Wadden Sea. Then, a massive and short migration takes place with a peak in early May.

While numbers in July indicate an "increase" with counted numbers between 5,000 and 9,000, numbers in August are more shaky, with a maximum of 18,500 counted in 1994 (24,500 estimated) and 15,100 in 1996 (16,500 estimated), the trend estimate is a "decrease". In contrast, these numbers are considerably higher than the actual counted numbers of the former decade. The vast majority of Spotted Redshanks in August are counted in The Netherlands and Schleswig-Holstein.

May numbers peak in 1995 with 20,700 counted birds (26,700 estimated), but are drastically lower in all the following years, leading to a "substantial decrease" for the period 1992-2000. Since imputed numbers in May are reasonably low, it seems that none of the major sites has been missed during the counts; the reasons for this decline are unknown.

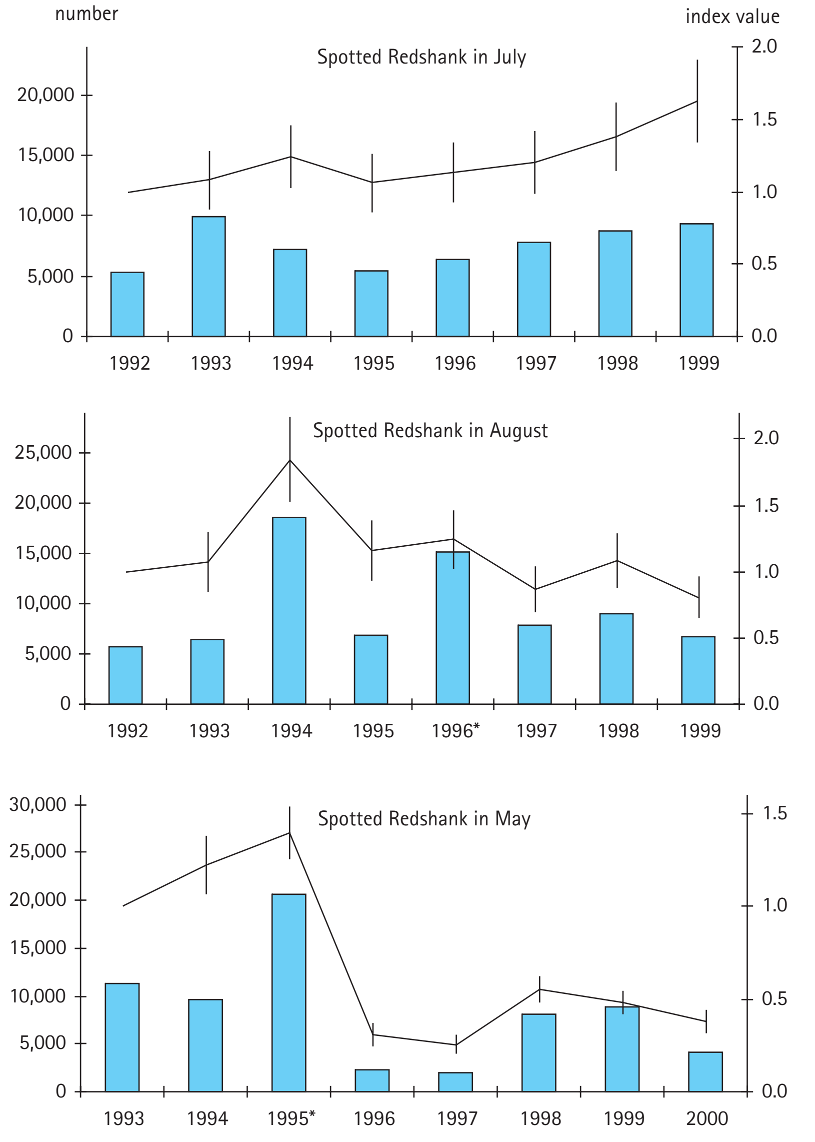


Figure 4.46: Spotted Redshank – Counted numbers (bars) and index values (lines) in July, August and May.

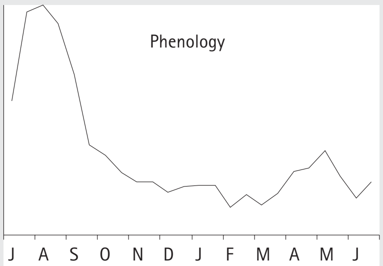
Conclusion

For both peak months, August and May, numbers were decreasing during 1992-2000. Both decreases seem to depend on single large counts. The single large counts also exceed the numbers of the former decade. In Germany, fluctuating numbers are reported both for autumn and spring, however, with a decreasing tendency (Blew *et al.*, 2005). An overall stable situation is described for the Dutch Wadden Sea (van Roomen *et al.*, 2004).

4.28 Common Redshank

Tringa totanus

05460 DK: Rødben D: Rotschenkel NL: Tureluur



Subspecies / population: Breeding or wintering or core non-breeding range	Estimate	1% level	Trend
*robusta**: Iceland & Faeroes (breeding)	64,500	650	STA/INC
totanus: E Atlantic (non-breeding)	250,000	2,500	DEC
*Population that winters in the Wadden Sea area			

(source: Wetlands International, 2002)

	1980-1991	1992-2000 arithm. mean of 3 max results		Flyway population
	estimated	counted	estimated	%
summer	9,800	37,348	55,259	22.1
autumn	**59,600**	42,189	**65,077**	26.0
winter	16,400	16,979	20,669	31.8
spring	35,000	20,042	23,810	9.5

Trend estimates	1992-2000	1980-2000
overall	--	S
autumn	-	
January	--	F
spring	F/--	

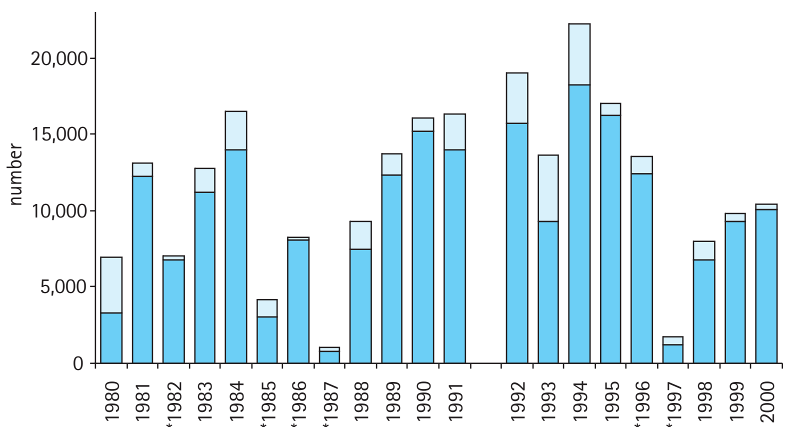
For explanation of tables and figure see page 35

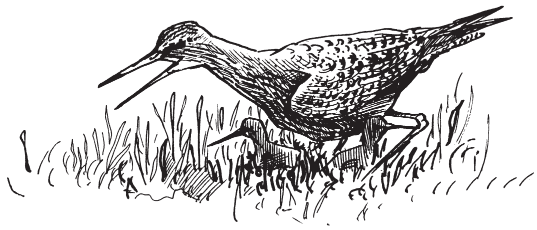
Three populations of Redshank use the Wadden Sea during the yearly cycle. The *Tringa t. totanus* population, some 250,000 birds, is separated into the "Northern" population breeding in Fennoscandia and the "Southern" population breeding in Southern Scandinavia, the Baltic region and the Wadden Sea area. The *Tringa t. robusta* population, estimated at 64,500 birds, breeds in Iceland and the Faeroes and some of those winter in the Wadden Sea (Meltofte *et al.*, 1994; Wetlands International, 2002). A total of 12,835 pairs breed in the Wadden Sea area (Rasmussen *et al.*, 2000).

In late July, the resident breeding population ("Southern") starts moving West and South, while shortly after, birds of the "Northern" and the *robusta* population move into the Wadden Sea area. Numbers decrease during autumn, when most of the *totanus* birds leave the Wadden Sea. In winter, numbers vary depending on the weather, in cold winters most birds leave the Wadden Sea. Birds reappear in the Wadden Sea during March and April with a small peak in May. Some of those will be local breeders and some move through.

Trend calculations for January 1992-2000 (excluding the cold winters) indicate a "substantial decrease", representing the *robusta* population. As for many other species, the January results seem to represent weather effects. January numbers

Figure 4.47: Estimated numbers of Redshank in January (blue = counted, light blue = imputed).





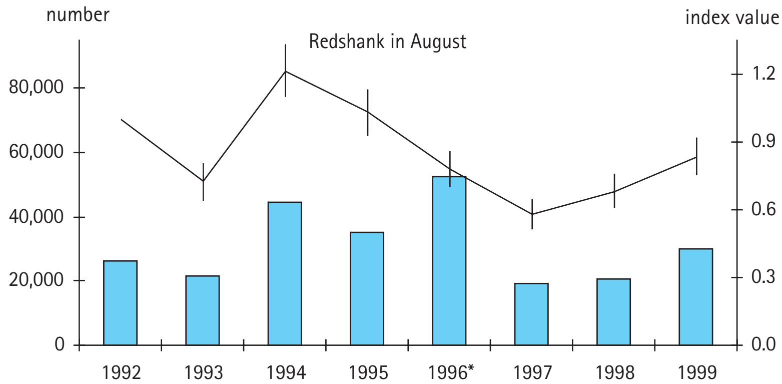


Figure 4.48: Redshank - Counted numbers (bars) and index values (lines) in August.

were on a high level during the mild winters until 1995. In winter 1996 the majority of the Redshanks were found in The Netherlands, while in January 1997 most birds left the Wadden Sea altogether. The following winters numbers begin to build up again. January numbers 1980-2000 again show large fluctuations.

Peak numbers of Redshank were reached in August 1996 (52,200 counted and 53,800 estimated birds in August 1996), high imputed numbers in most other August counts should be taken with some caution. The August trend indicates a "decrease", while numbers are on the same level as during 1980-1991.

During spring, more than 20,000 Redshank were counted in April 2000 (21,500 counted, 23,700 estimated) and in May 1995 (21,200 counted and 22,600 estimated). For April, a "substantial decrease" applies for 1992-2000, and numbers are somewhat lower than in the previous decade. For May 1992-2000, no significant trend estimate can be calculated. During spring, numbers 1992-2000 compare well to the previous decade. Comparing the counted numbers with the breeding population, it seems likely that birds of the resident breeding population are not picked up completely during the migratory bird counts.

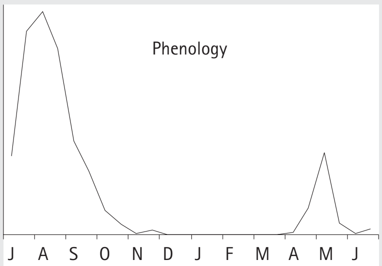
Conclusion

While the negative January trend for Redshank may be caused by the severity of the winters, both during spring and autumn decreasing numbers are also recorded, resulting in an overall substantial decrease of migratory Redshanks in the Wadden Sea. In Germany, decreases are also recorded for overall numbers (Blew *et al.*, 2005), while for the Dutch Wadden Sea overall Redshank numbers are stable (van Roomen *et al.*, 2004).

4.29 Common Greenshank

Tringa nebularia

05480 DK: Hvidklire D: Grünschenkel NL: Groenpootruiter



Subspecies / population: Breeding or wintering or core non-breeding range	**Estimate**	**1% level**	**Trend**
Europe (breeding)	234,000 - 395,000	3,100	STA

(source: Wetlands International, 2002)

	1980-1991	**1992-2000** arithm. mean of 3 max results		**Flyway population**
	estimated	**counted**	**estimated**	**%**
summer	120	8,959	12,565	4.1
autumn	**15,000**	12,777	**18,759**	6.1
winter	15	22	35	0.0
spring	6,970	4,814	5,572	1.8

Trend estimates	**1992-2000**	**1980-2000**
overall	-	S
autumn	-	
January		
spring	F	

For explanation of tables and figure see page 35

The population of Greenshank breeding in Scotland, Scandinavia and Northeast Europe (234,000-395,000, stable) uses a very large wintering area from West Europe to South Africa (Wetlands International, 2002).

Greenshank start to move into the Wadden Sea in late June, with peak numbers recorded in August. Birds leave the Wadden Sea over winter and move through in late April and early May. The Greenshank phenology for the entire Wadden Sea looks similar to that of the Spotted Redshank, however, Greenshank utilize other habitats (sandy/muddy areas) than Spotted Redshank (muddy areas), thus are less concentrated and use more sites overall (Meltofte *et al.*, 1994).

The highest counted number occurs at the synchronous count in August 1996 with 18,900 counted and 19,600 estimated birds. All other August counts show high imputed numbers; August indices result in a significant trend estimate "decrease". Compared to the previous decade, where the only August count yielded 10,200

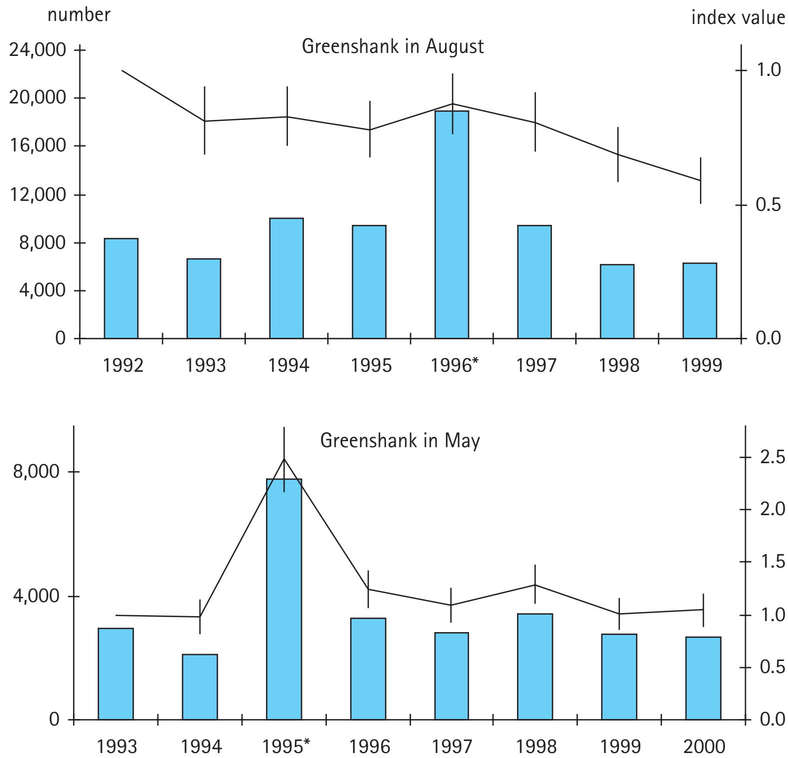


Figure 4.49: Greenshank - Counted numbers (bars) and index values (lines) in August and May.

counted and 15,000 estimated birds, numbers have increased.

In May, the highest count in 1995 was 7,800 counted and 8,200 estimated birds. As with Spotted Redshank, the 1995 numbers are exceptionally high, even though Greenshank individuals seem to be more evenly distributed between the countries. Data does not allow a trend estimate for this month.

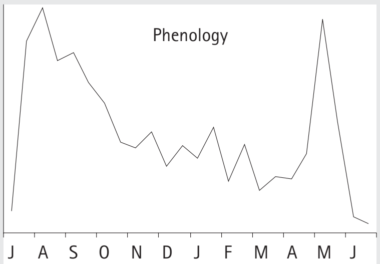
Conclusion

The small fraction of the Greenshank population utilizing the Wadden Sea shows higher numbers than during the previous decade; however, for August, a decreasing trend is calculated for 1992-2000. Germany reports fluctuating numbers for the migration months (Blew *et al.*, 2005), in the Dutch Wadden Sea overall Greenshank numbers are stable (van Roomen *et al.*, 2004).

4.30 Ruddy Turnstone

Arenaria interpres

05610 **DK: Stenvender** **D: Steinwälzer** **NL: Steenloper**



Subspecies / population: Breeding or wintering or core non-breeding range	Estimate	1% level	Trend
NE Canada, Greenland (breeding)	94,000	1,000	INC
* Fennoscandia, NW Russia (breeding)	46,000 - 119,000	830	STA

*Population that winters in the Wadden Sea area

(source: Wetlands International, 2002)

	1980–1991	1992–2000 arithm. mean of 3 max results		Flyway population
	estimated	counted	estimated	%
summer	379	1,746	2,404	2.9
autumn	5,090	3,912	**6,962**	8.4
winter	4,060	5,042	6,053	7.3
spring	**7,020**	4,329	5,586	6.7

Trend estimates	1992–2000	1980–2000
overall	--	S
autumn	S/--	
January	--	+ (n.s.)
spring	--	

For explanation of tables and figure see page 35

Two populations of Turnstone move through the Wadden Sea. The Fennoscandian and Northwest Russian population is estimated at between 46,000 and 119,000 and stable. The other population breeds in Greenland and Canada and numbers about 94,000 birds and is increasing (Meltofte *et al.*, 1994; Wetlands International, 2002).

In late July already large numbers of the Fennoscandian adults occur in the Wadden Sea, followed by the Nearctic adults and then by juveniles from both populations (Meltofte *et al.*, 1994). Numbers peak in August and decrease until most of the birds have left for their winter quarters in late October. Numbers stay low until a migration wave passes through in late April and early May.

While for January numbers 1992-2000 a "substantial decrease" is detected, the period 1980-2000 shows a slight but not significant increase. The high number of 4,900 counted and 5,800 estimated birds in January 1995 indicates that due to a series of mild winters, more Turnstones seem to stay in the Wadden Sea area. After the cold winters 1996 and 1997, however, January numbers stayed low – as expressed by the negative trend.

The numbers of 4,000 or 3,500 counted birds in

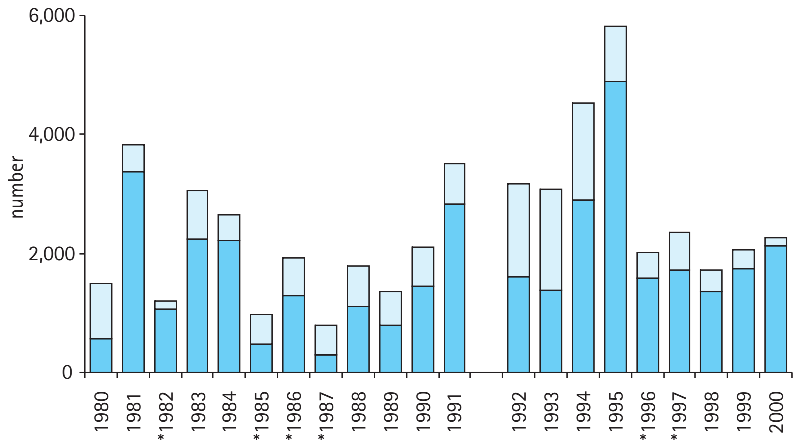


Figure 4.50: Estimated numbers of Turnstone in January (blue = counted, light blue = imputed).

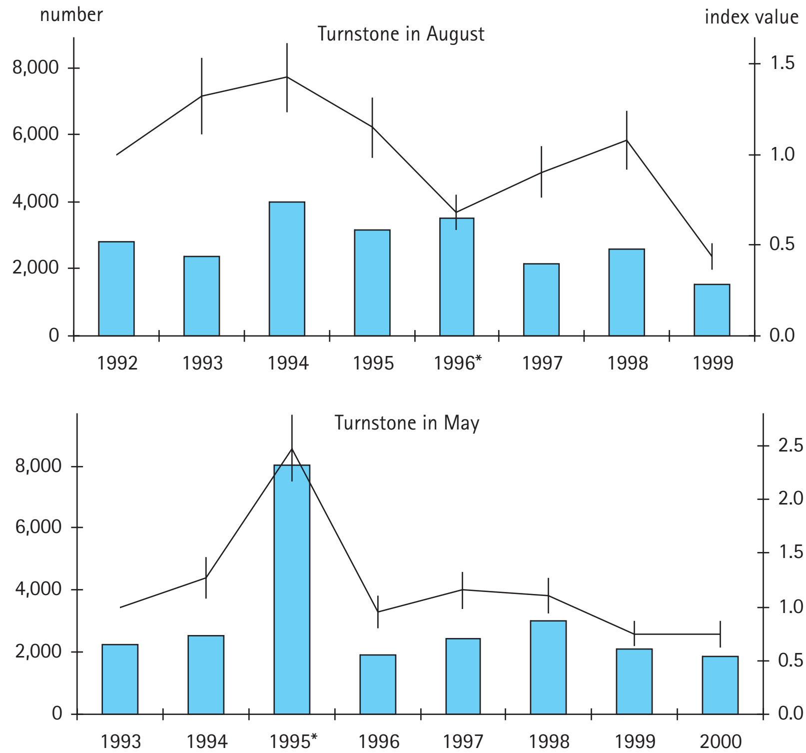


Figure 4.51: Turnstone – Counted numbers (bars) and index values (lines) in August and May.

August 1994 or 1996 (7,600 and 3,700 estimated) compare well to the numbers of the previous decade, however, most August results include a high proportion of imputed numbers. The trend estimate for August 1992-2000 is a "substantial decrease", while for September numbers strongly fluctuate and show no trend.

All April counts stay below 2,000 counted birds, but the synchronous May count in 1995 yielded 8,000 counted and 8,500 estimated birds. This count is higher than all Turnstone counts of the period 1980-1991. The trend for May 1992-2000, however, is a "substantial decrease".

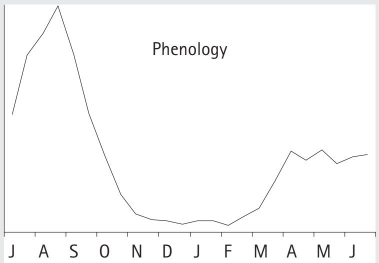
Conclusion

Most trend estimates (January, May and August) indicate "substantial decreases", leading to an overall substantial decrease. Long term numbers seem to be stable. These interpretations should be taken with some caution, since Turnstone utilize non-estuarine habitats outside the usual counting units (Blew *et al.*, 2005). German numbers also show large fluctuations with a decreasing tendency (Blew *et al.*, 2005); the same is true for The Netherlands (van Roomen *et al.*, 2004).

4.31 Common Black-headed Gull

Larus ridibundus

05820 DK: Hættemåge D: Lachmöwe NL: Kokmeeuw



Subspecies / population: Breeding or wintering or core non-breeding range	**Estimate**	**1% level**	**Trend**
N & C Europe (breeding)	5,600,000–7,300,000	20,000	INC

(source: Wetlands International, 2002)

	1980–1991	**1992–2000** arithm. mean of 3 max results		**Flyway population**
	estimated	**counted**	**estimated**	**%**
summer	122,000	162,435	228,236	11.4
autumn	**242,000**	337,953	**498,834**	24.9
winter	38,900	23,000	37,509	1.9
spring	135,000	119,399	133,896	6.7

Trend estimates		
	1992–2000	**1980–2000**
overall	F	+
autumn	+	
January		+ (n.s.)
spring	S/-	

For explanation of tables and figure see page 35

The European population of Black-headed Gull is estimated at between 5.6 and 7.3 million birds and increasing (Wetlands International, 2002). The breeding population in the Wadden Sea area has leveled off at circa 133,000 pairs in 1996 (Rasmussen *et al.*, 2000).

Due to the local breeders numbers are on a high level during summer and increase with birds leaving their breeding area as well as moving in from outside the Wadden Sea area. Numbers peak in August and continuously decrease until November. Numbers during winter are low because birds move west and south or go to inland habitats and thus are not found in the Wadden Sea habitats. Beginning in March, numbers increase, consisting mainly of local breeders. During the breeding season, only a fraction of those are covered by our counts, because the breeding colonies are not located at the main counting units.

Trend calculations in January 1992-2000 indicate a "substantial decrease", for the period 1980-2000 an insignificant slight increase is calculated. These results are considerably limited by the fact that especially in winter gulls are not well covered during the counts.

After the breeding season, peak results are

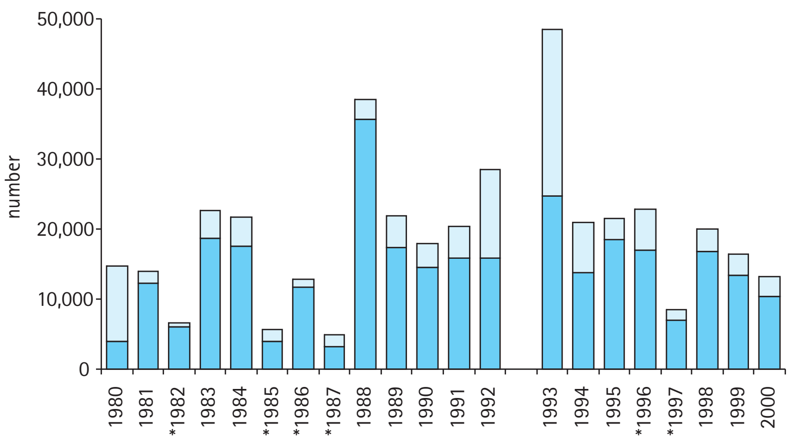
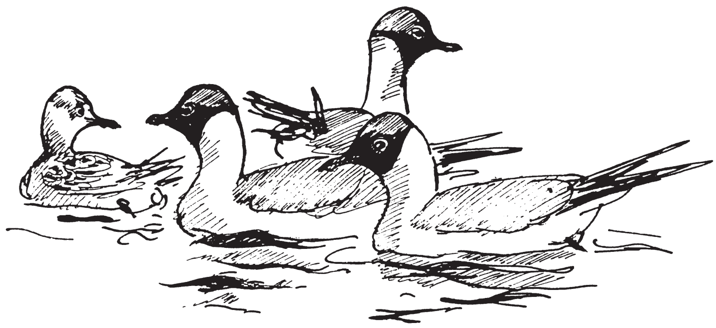


Figure 4.52: Estimated numbers of Black-headed Gull in January (blue = counted, light blue = imputed).



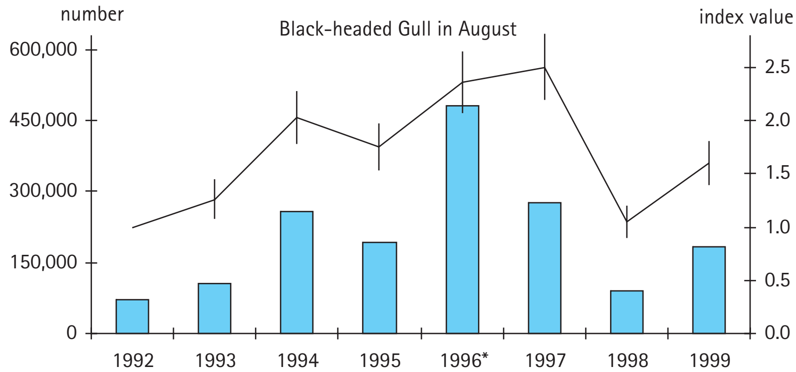


Figure 4.53: Black-headed Gull – Counted numbers (bars) and index values (lines) in August.

reached in August with 480,700 birds counted (512,200 estimated) in 1996. Numbers decrease to some degree in September, thus in the 1999 count 363,200 birds were counted (437,400 estimated), all other September numbers are below 200,000 counted individuals. Trends in August and September are "increases". The peak numbers of these months are considerably higher than those between 1980 and 1991 and suggest a long-term increase.

The synchronous count in April 2000 yields 161,600 counted birds (175,000 estimated). Both synchronous counts in May 1995 and June 1999 recorded some 120,000 birds plus low imputed numbers. While in April numbers exceeded those of the previous decade, in May numbers are on the same level. For the period 1992-2000, April numbers were stable and May numbers showed a "decrease". All spring numbers, however, are below the Wadden Sea breeding population.

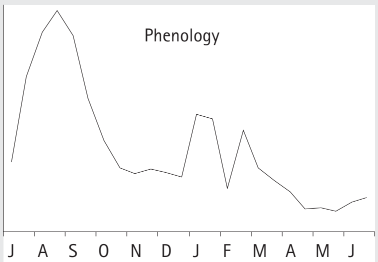
Conclusion

It is assumed that – as with other gulls – not all Black-headed Gulls utilizing the Wadden Sea area are actually registered during our counts. Outside the breeding season, many birds are found in harbors, on rubbish dumps, on meadows or arable land, follow fishing vessels or leave the counting areas during the high tide to elsewhere; large congregations might be found at night roosts (Meltofte *et al.*, 1994). Thus, the question is whether the increases during August and the decreases in April and May are true developments in the Wadden Sea. Overall numbers do not show a trend. Germany reports fluctuating numbers for August and September, but a decrease for January (Blew *et al.*, 2005); in the Dutch Wadden Sea, numbers fluctuate during the last 10 years (van Roomen *et al.*, 2004) and in Denmark, numbers decrease (Laursen and Frikke, in prep.).

4.32 Common Gull

Larus canus

05900 **DK: Stormmåge** **D: Sturmmöwe** **NL: Stormmeeuw**



Subspecies / population: Breeding or wintering or core non-breeding range	**Estimate**	**1% level**	**Trend**
Europe, N Africa (non-breeding)	1,300,000-2,100,000	17,000	DEC

(source: Wetlands International, 2002)

	1980-1991	1992-2000 arithm. mean of 3 max results		Flyway population
	estimated	counted	estimated	%
summer	18,400	49,340	74,605	4.4
autumn	**103,000**	177,143	**197,624**	11.6
winter *	58,100	91,834	136,817	8.0
spring	42,000	43,197	57,177	3.4

Trend estimates	1992-2000	1980-2000
overall	F	+
autumn	F/+	
January	--	++
spring		

For explanation of tables and figure see page 35

The North European population of the Common Gull is estimated between 1.3 and 2.1 million birds and decreasing (Wetlands International, 2002). The increasing breeding population in the Wadden Sea consisted of 6,118 pairs in 1991 and 10,442 pairs in 1996 (Rasmussen *et al.*, 2000).

Birds from the local breeding colonies and those of Scandinavia and the Baltic countries arrive in the Wadden Sea as early as late June and peak in August. Juveniles start leaving the Wadden Sea followed by the adults in October or November. Towards spring numbers keep decreasing while a distribution shift takes place with more birds appearing in the North and Eastern parts of the Wadden Sea. Common Gulls leave for their breeding places either outside or within the Wadden Sea and are not well covered during the April and May counts (Meltofte *et al.*, 1994).

In winter, 101,100 Common Gulls were counted and 135,600 estimated in January and also in February in the peak year 1996, twice as many as in the maximum winter count between 1980 and 1991. Some 60% of these birds were counted in The Netherlands, during some years this proportion is even higher. Apparently, cold winters have only a moderate effect on this species. The trend estimates for January 1992-2000 indicate "substantial decreases" for Common Gulls with

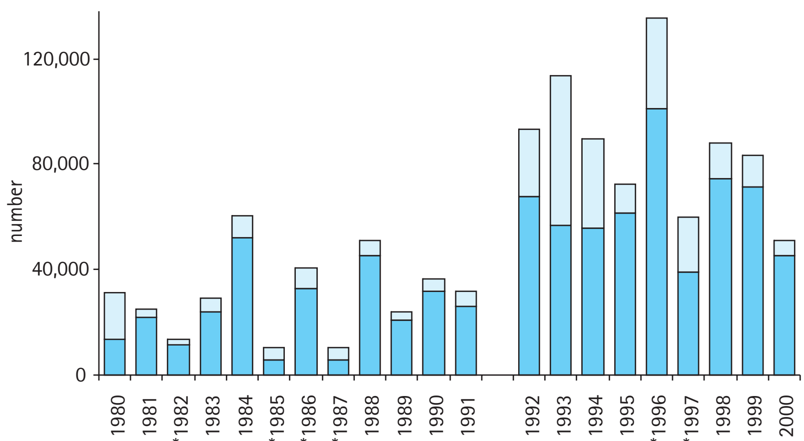


Figure 4.54: Estimated numbers of Common Gull in January (blue = counted, light blue = imputed).

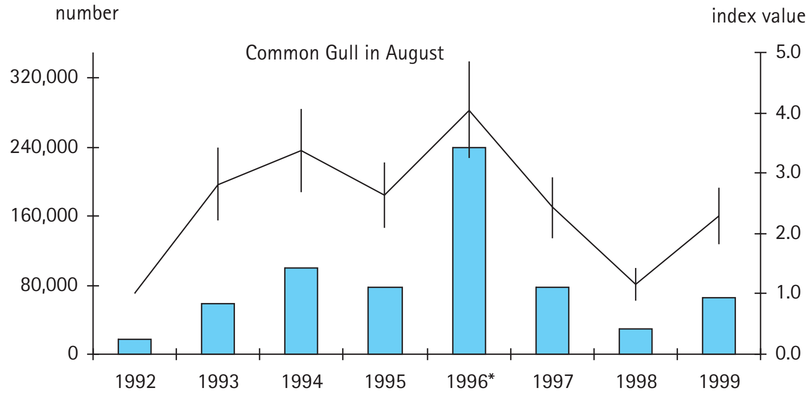


Figure 4.55: Common Gull - Counted numbers (bars) and index values (lines) in August.

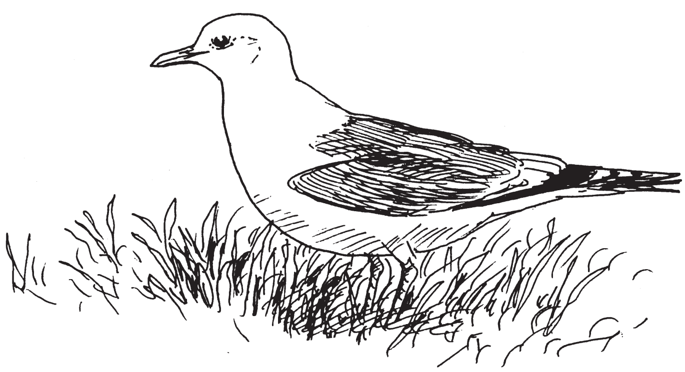
or without taking into account the cold winters. However, this must be seen in light of the considerable increase compared to the previous decade. The long-term trend 1980-2000 is still a substantial increase.

In August 1996, 239,700 individuals were counted (258,200 estimated), more than twice as many as in any count during 1980-1991. Numbers are lower in September, however, a count in September 1999 yielded 181,300 counted and 224,300 estimated birds. Trend estimates for August suffer from the high variation in those counts, they are not statistically significant, however, indicating a more or less stable situation. For September, a "substantial increase" has been calculated.

Since Common Gull show large distribution shifts during spring, no trend analysis has been performed for that season.

Conclusion

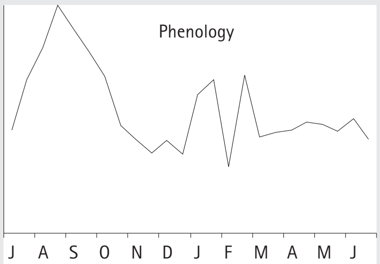
Trend estimates during winter are "substantial decreases", while for August fluctuating, but stable numbers, and for September "substantial increases" are recorded; overall numbers do not show a trend. This must be seen in light of the fact, that Common Gull numbers have considerably increased compared to the previous decade. In Germany, Common Gull numbers are fluctuating during migratory months (Blew *et al.*, 2005), but are decreasing in Denmark (Laursen and Frikke, in prep.).



4.33 Herring Gull

Larus argentatus

05920 DK: Sølvmåge D: Silbermöwe NL: Zilvermeeuw



Subspecies / population: Breeding or wintering or core non-breeding range	**Estimate**	**1% level**	**Trend**
*argentatus**: N & W Europe (non-breeding)	1,100,000-1,500,000	13,000	INC
argenteus: NW Europe S to N Iberia (non-breeding)	1,090,000	11,000	

* Population that winters in the Wadden Sea Area

(source: Wetlands International, 2002)

	1980-1991	**1992-2000** arithm. mean of 3 max results		**Flyway population**
	estimated	**counted**	**estimated**	**%**
summer	79,200	69,143	90,665	8.2
autumn	**328,000**	178,523	**242,677**	22.1
winter	157,000	149,817	209,279	19.0
spring	141,000	86,926	118,066	10.7

Trend estimates		
	1992-2000	**1980-2000**
overall	-- (n.s.)	-
autumn	S/-	
January	F	++ (n.s.)
spring	-	

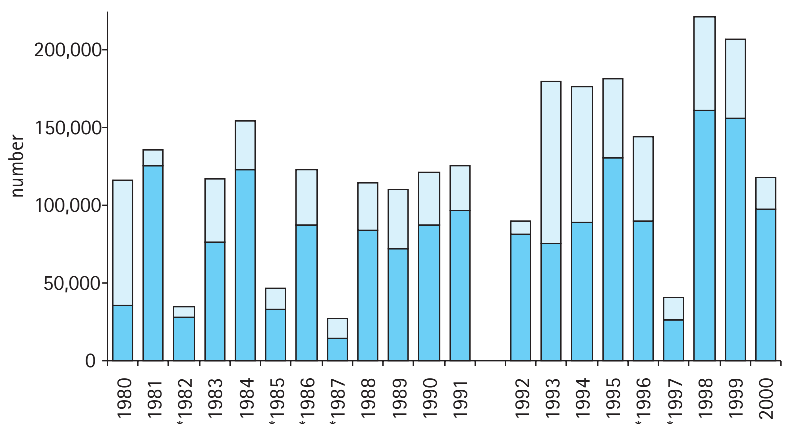
For explanation of tables and figure see page 35

Two populations of Herring Gull utilize the Wadden Sea area. The nominate subspecies *L. a. argentatus* breeding in Fennoscandia East to the Kola Peninsula is a true migratory species, numbering 1,100,000-1,500,000 individuals and increasing, while the *L. a. argenteus* population breeds in Western Europe, shows only short-distance migration and numbers about 1,090,000 birds with an unclear trend status (Wetlands International, 2002). The breeding population numbered 89,577 pairs in 1991 and 77,250 pairs in 1996 (Rasmussen *et al.*, 2000) and represents most of the birds counted in the Wadden Sea.

In late summer, when Herring Gulls have left their breeding colonies and migrants immigrate from Scandinavia, Baltic Areas and Great Britain numbers rise reaching peaks in late August and September and decrease from then on. Up to 100,000-150,000 birds overwinter in the Wadden Sea area, but in cold winters numbers further decrease; however, then Herring Gulls might be found inland concentrating in rubbish dumps or harbors (Meltofte *et al.*, 1994). Between January and April numbers largely fluctuate, from April on the breeding individuals are not adequately covered by the counts anymore.

The trend of January numbers 1992-2000 appears to be stable, but data is insufficient to make this estimate significant. For 1980-2000, an insignificant increase exists.

Figure 4.56: Estimated numbers of Herring Gull in January (blue = counted, light blue = imputed).



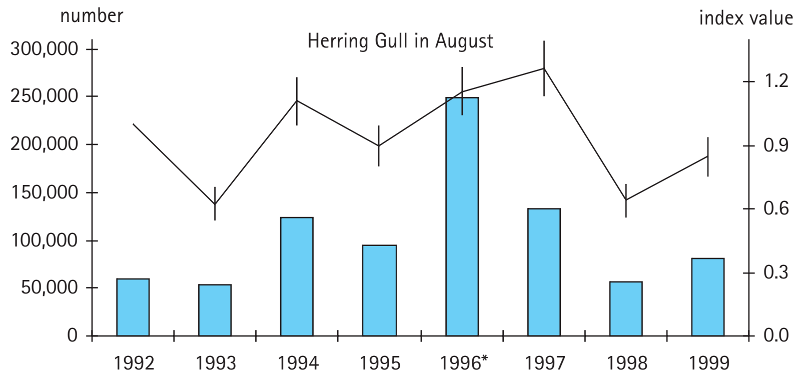


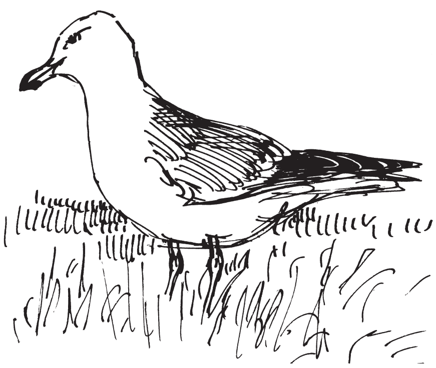
Figure 4.57: Herring Gull - Counted numbers (bars) and index

After the breeding season, Herring Gull numbers reach peaks in late August (249,000 counted and 254,500 estimated in August 1996) and September (167,600 counted and 201,600 estimated in 1999). Numbers of these months are lower than during the previous decade. During the peak months August and September, trend parameters for the period 1992-2000 indicate a "stable population" and a "decrease", respectively.

The maximum count in March 1998 with 118,300 counted birds (178,800 estimated) may still represent migratory Herring Gulls moving North. Later, most of the counted numbers in May and June stayed below 50,000 birds and thus well below the local breeding population. These differences result from the fact that breeding colonies are not included in the migratory birds counts and that gulls in general are not well covered during the counts. The synchronous count in June 1999 yielded 93,300 counted birds (102,200 estimated), most probably birds which had already left the breeding colonies. During 1992-2000, both March and April numbers of Herring Gull were decreasing.

Conclusion

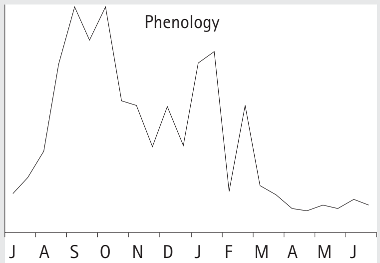
The fraction of the Herring Gull populations utilizing the Wadden Sea seems to be stable or slightly decreasing. Trends might be local and dependent on counting effort and coverage. More than in other species it appears, that only during the months of synchronous counts is a sufficient coverage of this species reached, leading to high imputed numbers in all other months. The Herring Gull preys – as do Common Eider and Eurasian Oystercatcher – on shellfish, especially on young mussel beds. However, as they use other food sources opportunistically, their population development is less dependent on shell fishery than that of the other two species (see Scheiffarth and Frank, 2005, this volume). In Germany, Herring Gull numbers are decreasing in autumn and spring in particular after 1996 (Blew *et al.*, 2005), in the Dutch Wadden Sea, an overall decrease occurs (van Roomen *et al.*, 2004).



4.34 Great Black-backed Gull

Larus marinus

06000 DK: Svartbag D: Mantelmöwe NL: Grote Mantelmeeuw



Subspecies / population: Breeding or wintering or core non-breeding range	Estimate	1% level	Trend
NE Atlantic	420,000-510,000	4,700	STA

(source: Wetlands International, 2002)

	1980-1991	1992-2000 arithm. mean of 3 max results		Flyway population
	estimated	counted	estimated	%
summer	1,700	1,860	2,341	0.5
autumn	**15,400**	12,429	16,242	3.5
winter	**7,950**	12,973	**16,309**	3.5
spring	3,910	1,953	2,676	0.6

Trend estimates	1992-2000	1980-2000
overall	- (n.s.)	S
autumn	--/++	
January	++	++
spring	F	

For explanation of tables and figure see page 35

The population of the Northeast Atlantic Great Black-backed Gull is estimated between 420,000 and 510,000 birds and stable (Wetlands International, 2002). Very few birds breed in the Wadden Sea, in 1996 a total of 15 pairs was recorded (Rasmussen *et al.*, 2000).

Beginning in July, Great Black-backed Gulls move into the Wadden Sea from their Norwegian, Fennoscandian and Russian breeding grounds (Meltofte *et al.*, 1994). Peak numbers are reached during August and September. In winter, numbers are generally somewhat lower, however, large fluctuations convolute the phenology pattern. In general, numbers decrease during spring, dropping considerably already in March.

Winter numbers since 1980 have generally been below 7,000 birds. Then, in the years 1998 and 1999, 13,300 and 16,100 individuals were counted (17,600 and 18,400 estimated), remarkably more than in any counts before. Of these, more than two-thirds were counted in The Netherlands and most of the rest in Denmark. The trend for

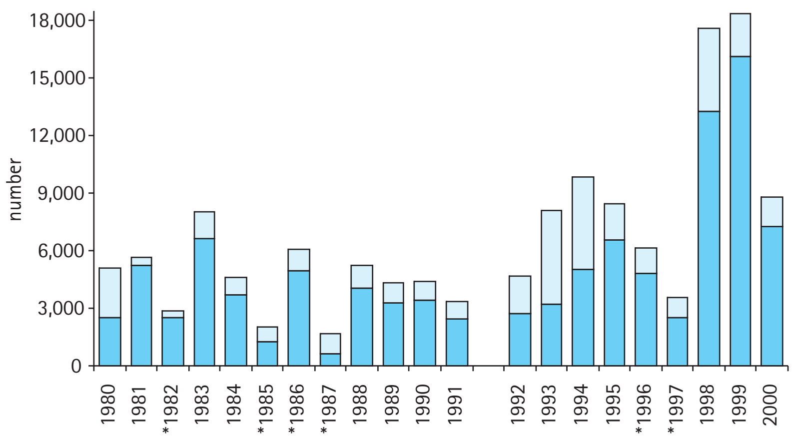


Figure 4.58: Estimated numbers of Great Black-headed Gull in January (blue = counted, light blue = imputed).

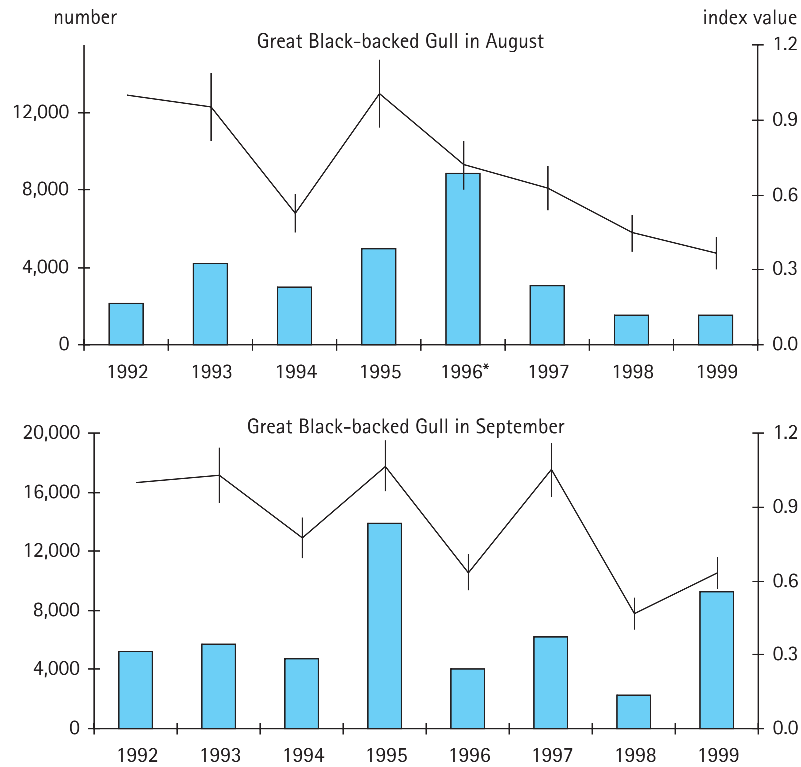


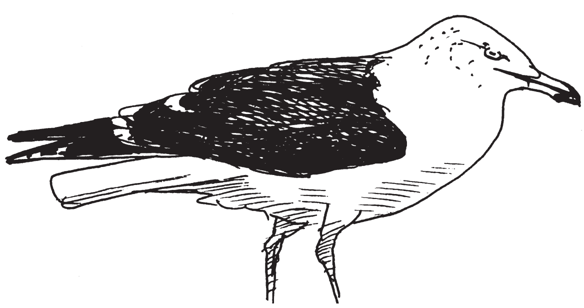
Figure 4.59: Great Black-headed Gull – Counted numbers (bars) and index values (lines) in August and September.

January 1992-2000 was a "substantial increase", as was the long-term trend 1980-2000.

Counts during the autumn yield 8,900 counted and 9,200 estimated birds August 1996; in September 1995, 13,800 counted and 18,100 estimated birds were reached. Again, these peak numbers are higher than those of the previous decade. Trend estimates for August and September are both "substantial decreases".

Conclusion

In general, numbers of Great Black-backed Gulls in the Wadden Sea fluctuate heavily; an overall slightly negative trend is not significant and it is unclear whether these results are true trends or largely influenced by counting coverage and effort. In the Dutch and German Wadden Sea, numbers are fluctuating (van Roomen *et al.*, 2004, Blew *et al.*, 2005).



5. Discussion

The following discussion pursues a broad approach. It takes a look at the patterns of numbers and trends of waterbirds using the international Wadden Sea and presents an assessment of the reliability of the results. A sophisticated scientific analysis of the results and underlying factors is beyond the scope of this report. The question is, whether the current monitoring program plus the data exchange and analyses performed suffice to document the population development of the migratory waterbirds in the international Wadden Sea in a way which will finally contribute to a better protection of these species.

5.1 Maximum numbers and proportions of flyway populations

A total of 34 species and a total of 44 distinct geographical populations have been considered in this report. It concerns those species which are regarded as typical migratory Wadden Sea species and which occur in high numbers.

Adding up all maximum numbers results in some 4.4 million counted birds in the Wadden Sea, and more than 6 million birds estimated (Table 5.1). Besides Great Cormorant and Eurasian Spoonbill, counted sums are 1.36 million ducks and geese (1.63 million estimated), 2.29 million waders (3.46 million estimated) and 707,000 gulls (955,000 million estimated). Highest numbers of total waterbirds are reached during the autumn migration from July onwards. Ducks stay in high numbers throughout winter, while wader numbers are lower during winter but are again very high during spring migration. Gulls have similar numbers during spring, autumn and winter.

These figures do not take into account turnover since they refer to counts carried out simultaneously. When regarding the continuous arrival and departure of many migratory birds, many more individuals utilize the Wadden Sea; as estimated by Meltofte *et al.* (1994) this may involve 10-12 million individuals (*e.g.* Frederiksen *et al.*, 2001; Hötker and Frederiksen, 2001).

Changes compared to the period 1980-1991

In contrast to the period 1980-1991, maximum numbers for the period 1992-2000 have been calculated by taking the arithmetic mean of the three maximum values (Chapter 2.7). This method for calculating the maximum numbers leads to generally lower values compared to the previous period 1980-1991 (Meltofte *et al.*, 1994).

Table 5.1: Total counted and estimated numbers, summed up for species groups.

Season	Species group	Counted numbers	Estimated numbers
Summer	ducks and geese	173,000	269,000
	waders	468,000	695,000
	gulls	283,000	396,000
	totals	**924,000**	**1,360,000**
Autumn	ducks and geese	759,000	1,142,000
	waders	2,097,000	3,294,000
	gulls	706,000	955,000
	totals	**3,562,000**	**5,391,000**
Winter	ducks and geese	1,001,000	1,231,000
	waders	1,259,000	1,593,000
	gulls	278,000	400,000
	totals	**2,538,000**	**3,224,000**
Spring	ducks and geese	672,000	845,000
	waders	1,798,000	2,355,000
	gulls	251,000	312,000
	totals	**2,721,000**	**3,512,000**
Total year	ducks and geese	1,360,000	1,626,000
	waders	2,293,000	3,458,000
	gulls	707,000	955,000
	totals	**4,360,000**	**6,039,000**

For 14 species, maximum numbers during 1992-2000 are more than 10% higher than during 1980-1991 (Table 5.2). There may be several reasons:

- some species – namely Eurasian Spoonbill, Great Cormorant, Barnacle Goose, Brent Goose (up to 1996), Eurasian Curlew, Black-headed and Common Gull - have shown long-term increases (see Chapters 5.2.2 and 5.2.3);
- for other less numerous species – namely Northern Shoveler, Great Ringed Plover, Curlew Sandpiper, Whimbrel, Spotted Redshank, Common Greenshank - the increase might be caused by better coverage of months outside January. Compared to the previous report, considerably more data outside January has been used to calculate total numbers. For example, during 1980-1991 for August, one of the peak migratory months in the Wadden Sea, only one synchronous count, August 1982 has been listed for counted numbers, and only a few counts had been available to account for missing values. For the recent analysis, the international count in August 1996 did indeed yield the highest numbers for most species, however, counts of August 1992-2000 have been used to extract maximum numbers and imputing has been carried out for all August counts within this period.

Seven species seem to occur in lower numbers compared to the period of 1980-1991; three of those - Shelduck, Eider and Knot - occur in huge

Table 5.2:
Maximum numbers in the Wadden Sea per species during 1980–1991 (Meltofte et al. 1994) and during 1992–2000 (Blew et al. 2004). Population estimates and ranges are taken from Wetlands International (2002). winter - the population which overwinters in the Wadden Sea area; species included in Annex I of the EU-Bird Directive are marked with an asterisk (*); species which also breed in the Wadden Sea, are printed in bold. For calculation of numbers see text.

Species		Maximum number in the Wadden Sea estimated 1980-1991	1992-2000	Population Estimate	Population Range
Great Cormorant	*Phalacrocorax carbo sinensis*	4,660	17,200	275,000- 340,000	N, Central Europe
Eurasian Spoonbill *	*Platalea leucorodia*	262	1,090	9,950	East Atlantic
Barnacle Goose *	*Branta leucopsis*	103,000	278,000	360,000	N Russia, E Baltic (breeding)
Dark-bellied Brent Goose	*Branta b. bernicla*	220,000	255,000	215,000	W Siberian (breeding)
Common Shelduck	*Tadorna tadorna*	254,000	219,000	300,000	NW Europe (breeding)
Eurasian Wigeon	*Anas penelope*	320,000	333,000	1,500,000	NW Europe (non-breeding)
Common Teal	*Anas crecca*	56,600	38,700	400,000	NW Europe (non-breeding)
Mallard	*Anas platyrhynchos*	165,000	170,000	4,500,000	NW Europe (non-breeding)
Northern Pintail	*Anas acuta*	16,200	15,900	60,000	NW Europe (non-breeding)
Northern Shoveler	*Anas clypeata*	3,960	6,030	40,000	NW & C Europe (non-breeding)
Common Eider	*Somateria mollissima*	309,000[1]	311,000[1]	850,000-1,200,000	Baltic, Wadden Sea
Eurasian Oystercatcher	*Haematopus ostralegus*	739,000	582,000	1,020,000	Europe, NW Africa
Pied Avocet *	*Recurvirostra avosetta*	44,600	46,400	73,000	W Europe (breeding)
Great Ringed Plover	*Charadrius h. hiaticula* winter		{	73,000	Europe, N Africa (non-breeding)
	Charadrius h. tundrae	14,100	32,900 {	145,000-280,000	SW Asia, E&S Africa (non-breeding)
	Charadrius h. psammodroma		{	190,000	W&S Africa (non-breeding)
Kentish Plover *	*Charadrius alexandrinus*	812	704	62,000-70,000	E Atlantic, W Mediterranean
Eurasian Golden Plover *	*Pluvialis apricaria*			69,000	NW Europe (non-breeding)
	winter	168,000	153,000 {	930,000	W & S Continental Europe, NW Africa (non-breeding)
Grey Plover	*Pluvialis squatarola*	140,000	106,000	247,000	E Atlantic (non-breeding)
Northern Lapwing	*Vanellus vanellus*	132,000	113,000	2,800,000-4,000,000	Europe (breeding)
Red Knot	*Calidris c. canutus*			340,000	Central Siberia (breeding)
	Calidris c. islandica winter	433,000	339,000 {	450,000	Greenland, High Arctic Canada (breeding)
Sanderling	*Calidris alba*	20,200	20,300	123,000	E Atlantic, W&S Africa (non-breeding)
Curlew Sandpiper	*Calidris ferruginea*	6,680	10,700	740,000	W Africa (non-breeding)
Dunlin	*Calidris alpina*			1,330,000	W Europe (non-breeding)
	Calidris alpina schinzii *[2]	1,200,000	1,380,000 {	3,600-4,700	Baltic (breeding)
Ruff *	*Philomachus pugnax*	19,800	5,250	2,200,000	W Africa (non-breeding)
Bar-tailed Godwit *	*Limosa l. lapponica* winter			120,000	Coastal W Europe, NW Africa (non-breeding)
	Limosa l. taymyrensis	341,000	273,000 {	520,000	Coastal W & SW Africa (non-breeding)
Whimbrel	*Numenius phaeopus*	1,330	2,120	160,000-300,000	NE Europe (breeding)
Eurasian Curlew	*Numenius arquata*	227,000	279,000	420,000	W, Central & N Europe (breeding)
Spotted Redshank	*Tringa erythropus*	15,200	18,800	77,000-131,000	Europe (breeding)
Common Redshank	*Tringa t. robusta* winter			64,500	Iceland & Faeroes (breeding)
	Tringa t. totanus	59,600	65,100 {	250,000	E Atlantic (non-breeding)
Common Greenshank	*Tringa nebularia*	15,000	18,800	234,000-395,000	Europe (breeding)
Ruddy Turnstone	*Arenaria interpres* winter			94,000	NE Canada, Greenland (breeding)
		7,020	6,960 {	46,000-119,000	Fennoscandia, NW Russia (breeding)
Common Black-headed Gull	*Larus ridibundus*	242,000	499,000	5,600,000-7,300,000	N & C Europe (breeding)
Common Gull	*Larus canus*	103,000	198,000	1,300,000-2,100,000	Europe, N Africa (non-breeding)
Herring Gull	*Larus a. argentatus* winter			1,100,000-1,500,000	N & W Europe (non-breeding)
	Larus a. argenteus	328,000	243,000 {	1,090,000	NW Europe S to N Iberia (non-breeding)
Great Black-backed Gull	*Larus marinus*	15,400	16,300	420,000-510,000	NE Atlantic

[1] Numbers of Common Eider are derived from extra aerial counts in January outside the JMMB Program.
[2] Only the population *Calidris alpina schinzii* is included in the Annex I of the EU-Bird Directive.

flocks and are not easy to cover during counts, another three of those species - Oystercatcher, Grey Plover and Herring Gull - are all considered in long-term decline in the Wadden Sea; the Teal is a species showing large fluctuations.

Importance of the Wadden Sea

Nine of 34 species utilize the Wadden Sea with more than 50% of their total population at some time in the yearly cycle, for an additional 14 species between 10% and 50% of their flyway population are present. Of the remaining 11 species, all but the Whimbrel and Ruff fulfill the 1% criterion of international importance (Figure 5.1). These findings cannot directly be compared to those of Meltofte *et al.* (1994), who for some species considered the possibility of turnover and thus estimated higher overall numbers.

Reliability of counted and estimated totals

Results of counted numbers are subject to counting errors of several sorts (Rappoldt *et al.*, 1985), however, for the very large number of counts it is believed, that variations in both over and underestimation are reasonably low. The proportion of imputed numbers within the estimated results, however, may give rise to some discussions. First of all, the imputed numbers are only "temporary" parameters for the trend calculation by TRIM. For single counting units or very small regions, it would not be just to show these numbers; for larger regions or – as is the case in this report – the combination of a high number of counting units to one entire region, the estimate of overall numbers is a reasonable approach integrating a large sum of counting units, of which each only contains a small amount of imputed numbers (Blew *et al.*, 2003).

However, some limitations apply:

- high and occasional numbers of species during one month may result in unreasonable proportions of imputed numbers in other months,
- numbers of those species which are hard to count, either because they have a very short migration period (*e.g.* Sanderling, Curlew Sandpiper) or because they congregate in huge flocks at a few places (*e.g.* Knot) can result in erroneous estimates.

Conclusion: The numbers and the proportions of the individual international flyway populations are reliable results based on a cautiously calculated approach and thus present minimum estimates of each species or population; if an even better

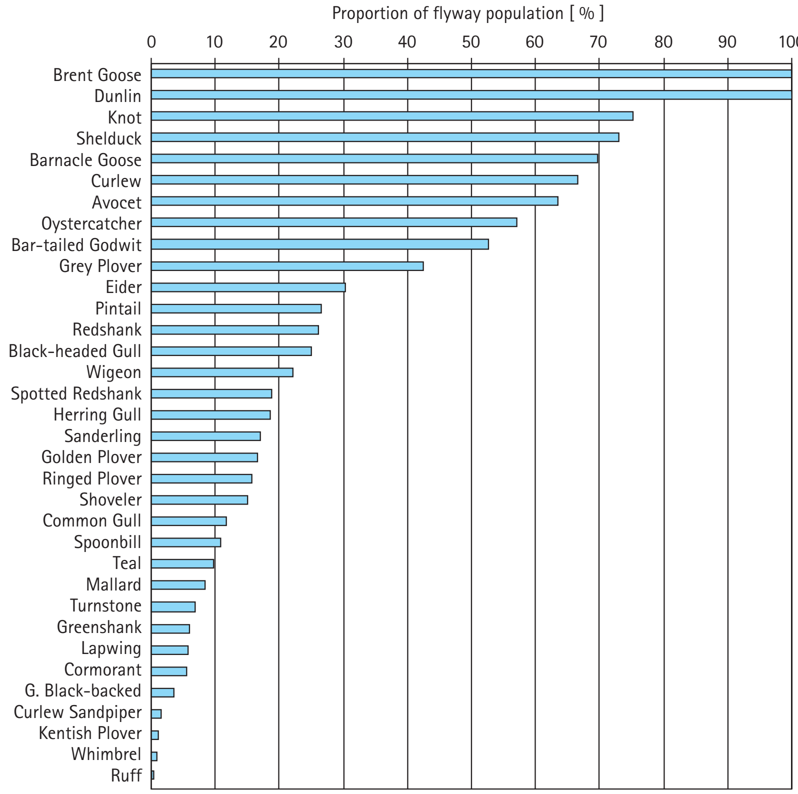


Figure 5.1: Proportions of flyway populations with regard to estimated numbers; values higher than 100%, resulting from population estimates of now decreasing species, are cut off.

counting coverage could be achieved and turnover of individuals were considered, many estimates could in fact be higher. These results again demonstrate the outstanding importance of the Wadden Sea for the migratory waterbirds.

5.2 Trends

This is the first time, that

- international Wadden Sea data has been subject to trend analyses outside January,
- the TRIM program has been used, which gives confidence limits to the index values and thus trend estimates are comparable to other studies,
- all Wadden Sea data for all countries has been compiled into one database in order to carry out the trend analysis.

Thus, this approach is a new start towards a coordinated trend analyses among the Wadden Sea countries.

5.2.1 Reliability of trend estimates

Trend estimates calculated with TRIM are only valid for the particular month for which the calculation has been carried out. There is good reason to say that if this month in the phenology of a species represents a peak occurrence time with regular numbers, the trend estimate for this species describes the utilization or the change in utilization of the Wadden Sea area. For some species one month would be sufficient to describe the trend (*e.g.* Sanderling, Curlew Sandpiper etc.). For several species, trend estimates of a few consecutive months during one season have been calculated. In most cases, trend estimates of those months do not contradict each other. If they do, this may mean a migration shift within the migratory season (see species accounts of Barnacle Goose and Dunlin). Thus, trend estimates per species are given for the respective seasons, but only one or two figures of the most representative months are shown in the species accounts. For species which exhibit much higher numbers in one season than in the others, it is valid to conclude that the trend of the season with the maximum numbers describes the species trend within the Wadden Sea. However, for species with a less pronounced phenology, different trends in different seasons are hard to interpret. In these cases, the overall usage of the Wadden Sea during one yearly cycle is better described with the overall trend. For 27 of 34 species, the overall trend is the same as the trend in the most important season(s), supporting the validity of this approach. For the other seven species, either fluctuating or contradictory seasonal trends exist.

No attempt has been made to carry out further trend calculations with covariates in order to analyze plausible causes with statistical methods. Firstly, for most potential covariates we do not have sound scientific data (habitat type and quality of counting units, food resources, disturbance, breeding success, winter mortality etc.). Secondly, adding covariates would require a higher amount and quality of counting data, since each covariate will sub-divide the existing database into smaller sub-units.

Even though we have used practically all the data available, for some months and species data does not suffice to arrive at significant trend estimates. This applies to species with fluctuating numbers in the Wadden Sea (*e.g.* ducks and other species whose main staging grounds are outside the Wadden Sea) and to species with very short migration peaks.

The period covered by this analysis, 1992-2000, is short and population developments may well take place over longer time periods. Even though comparable detailed data since 1980 has not been available, long-term trends have been assessed. Some of the short-term declining species have increased in the decade before, so that a "stable" situation can be stated for the period 1980-2000. However, for others of the short-term declining species, a long-term decline also applies. This points to the necessity of striving for the continued long-term monitoring of all waterbird species in the Wadden Sea and for continued compatibility of regional data to allow an analysis on the level of the entire Wadden Sea area.

5.2.2 Trends in winter
January numbers 1992 to 2000

For the winter (January) trends, winter weather acts as an important factor (see Figure 2.2 and Table 2.3)". A series of normal to mild winters beginning in 1988 up to 1995 caused some species to prolong their stay in the Wadden Sea area, thus increasing in January numbers from 1988 to 1995. The two cold winters 1996 and 1997 caused both considerable winter movement towards more southern areas and probably some winter mortality in some species. The normal winters 1998 and 1999 saw a moderate increase beginning at a lower level, whereas the mild winter of 2000 resulted for some species in a peak count. This pattern of mild, normal and cold winters imposes a strong bias on the January trend estimates; with waterbird winter numbers strongly dependent on winter temperature, a "decrease" in the Wadden Sea would be detected for the period 1992-2000.

The immediate reaction of the waterbirds to winter temperature can be seen during the two cold winters 1995/1996 and 1996/1997. As mentioned above (Chapter 2.5), the first cold spell of winter 1995/1996 was followed by a milder period and at the beginning of the following main cold spell of that winter the January count had already been conducted. Thus, the effects on bird numbers were not as heavy as during the following second cold winter 1996/1997. Then, temperature also dropped as early as December but the severe cold spell continued until the end of January; thus, bird numbers were lowest. With the exception of Sanderling and Turnstone, every single species count yielded lower numbers in January 1997 than in January 1996.

During January 1992-2000, of a total of 25 species present in the Wadden Sea with peak numbers > 1,000 individuals, ten are decreasing, seven are fluctuating and eight are increasing.

The weather is most probably the main cause for nine of the ten decreasing species: Brent Goose, Wigeon, Mallard, Eider (aerial counts), Oystercatcher, Redshank, Turnstone, Black-headed Gull, Common Gull; Shoveler showed a constant decrease during the series of mild winters, which continued up to 1998, and thus also shows a winter decrease.

Of the seven fluctuating species, four still seem to follow the weather pattern: Barnacle Goose, Golden Plover, Grey Plover, Curlew. The Sanderling seems to be the only wader species which does not visibly react to winter weather. Pintail show large fluctuations in winter, but the causes may lie outside the Wadden Sea. The Herring Gull shows stable numbers during winter, however, data is not significant.

For the increase in eight species, different explanations are possible:

Dunlin and Bar-tailed Godwit – these species show large fluctuations in winter but seem to follow the weather pattern. But both of them had their highest count ever in 2000, thus influencing the trend estimate;

Knot – this species shows large fluctuations during winter, but seems to also follow the winter pattern, however, the two highest winter counts ever in 1999 and 2000 cause a positive trend;

Shelduck – this species showed a moderate decrease from 1988 to 1997; but peak numbers in 1994 and 1995 plus an increase from 1997 to 2000 resulted in a positive trend; the reasons for this development are unknown.

The Great Black-backed Gull showed high counts 1998 and 1999, positively influencing the trend.

Conclusion: Winter numbers of most species wintering in the Wadden Sea follow the actual weather pattern. Thus, species trends in winter must be seen as regional phenomena with regard to the Wadden Sea area, while on flyway level the winter distribution is affected. 10 of 25 species showed "decreases" in winter in the Wadden Sea during the period 1992-2000. Also, three of the seven increasing species followed the weather pattern, but exhibited a positive trend because of very high numbers in the mild winter 2000. In cold winters, declines in the Wadden Sea in species such as Shelduck, Wigeon, Mallard, Pintail, Oystercatcher and Curlew were followed by high numbers in France (Deceuninck and Maheo, 2000), suggesting southbound displacements of birds which usually winter in the Wadden Sea.

January numbers 1980 to 2000

Looking at the period 1980 to 2000 and the effects of the winter severity, a modified picture appears for the Wadden Sea area. The winters 1982, 1985, 1986 and 1987 were cold winters. Then, a period of mild winters followed from 1988 to 1995, leading to increasing numbers up to 1995. Even though this period was followed by the two cold winters 1996 and 1997, these winter effects led to the result that during the longer period 1980 to 2000 none of the populations was decreasing in the Wadden Sea area. Six species show statistically significant substantial increases in winters during this period. Nine species show non-significant substantial increases, six more species show non-significant increases. The four remaining species fluctuate during winter.

Conclusion: The number of mild winters was increasing over the long-term period 1980-2000, leading to increasing numbers of waterbirds overwintering in the international Wadden Sea. These are most probably regional "trends" with regard to the Wadden Sea, but affect the winter distribution of the level of flyway populations. Considering the increasing frequency of milder winters on a longer term, wintering numbers and distribution in the Wadden Sea and on flyway level might change for some species in the future, as has been already reported for wintering wader populations in the UK, which have partly switched from the west to the east coast due to milder winters (Austin *et al.*, 2003).

5.2.3 Overall trends

Highest numbers in the Wadden Sea are reached during the autumn migration from the breeding grounds to the wintering quarters, that is - depending on the species – the period from July to November. From late February to May, most species move north again passing the Wadden Sea habitats; however, overall numbers are lower (Table 5.1). During these migratory periods the Wadden Sea serves as a staging and roosting habitat and weather influences are not as large as during the winter, when species may "decide" to stay or leave the area. Especially for the regional importance of the Wadden Sea itself with regard to support waterbird species, trends during those migration periods are valuable indicators. However, for the following analyses, the overall trend is used (Table 5.3).

Overall short-term trends 1992-2000

- 15 species (44%) are **decreasing**; of those, three are long-term decreasing, 12 are long-term stable (had increases in the decade before);
- six species (18%) show an insignificant **decrease**;
- three species (9%) are **increasing** and also long-term increasing;
- two species (6%) show an insignificant **increase**;

Table 5.3:
Trend estimates and selected parameters for each species. For calculation of numbers and for categories of trends see text. FP = Flyway population (Wetlands International, 2002); ++/-- substantial increase/decrease (> 20% in 10 years); +/- increase/decrease (< 20% in 10 years); F = fluctuating; S = stable; values in parentheses in column "overall - expert guess" = expert guess uncertain due to fluctuating species numbers.

				1992 - 2000			Trend estimates		
				arithm. mean of 3 max results			1992-2000	1980 - 2000	
Species	Wintering grounds	Breeding grounds	Food preference in Wadden Sea	Counted	Estimated	% FP	Overall (calculated)	Overall (expert guess)	January (calcu-lated)
Great Cormorant	W Eur. / Med.	non-arctic	Fish	12,826	17,176	5,5	++	+	++
Eurasian Spoonbill	trop. Afr / Med.	non-arctic	Benthos - shrimp	1,064	1,087	10,9	+	+	
Barnacle Goose	W Eur.	arctic	Herbivor	176,609	251,139	69,8	++	+	++
Dark-bellied Brent Goose	W Eur.	arctic	Herbivor	215,599	260,457	118,4	--	S	+ (n.s.)
Common Shelduck	W Eur.	non-arctic	Benthos	211,541	218,943	73,0	+ (n.s.)	+	F
Eurasian Wigeon	W Eur.	non-arctic	Herbivor	223,648	332,596	22,2	--	S	++
Common Teal	W Eur. / Med.	non-arctic	Herbivor / Benthos	26,227	38,706	9,7	F	S	F
Mallard	W Eur.	non-arctic	Herbivor / Benthos	131,636	170,157	8,5	--	-	+ (n.s.)
Northern Pintail	W Eur. / Med.	non-arctic	Herbivor / Benthos	12,180	15,901	26,5	- (n.s.)	F	+ (n.s.)
Northern Shoveler	W Eur. / Med.	non-arctic	Herbivor / Benthos / Plankton	3,795	6,031	15,1	F	(+)	+ (n.s.)
Common Eider	W Eur.	non-arctic	Benthos - Shellfish	311,318	311,318	30,2	F	S	++
Eurasian Oystercatcher	W Eur.	non-arctic	Benthos - Shellfish	443,433	581,904	57,0	--	-	F
Pied Avocet	trop. Afr / Med.	non-arctic	Benthos - Worm	34,012	46,358	63,5	--	S	
Great Ringed Plover	trop. Afr.	arctic	Benthos - Worm	21,805	32,909	15,7	+ (n.s.)	+	
Kentish Plover	trop. Afr / Med.	non-arctic	Benthos - Worm	477	704	1,1	F	(S)	
Eurasian Golden Plover	W Eur. / Med.	non-arctic	Benthos - Worm / Terrestrial	101,924	153,315	16,5	- (n.s.)	-	++ (n.s.)
Grey Plover	trop. Afr. / W Eur.	arctic	Benthos - Worm	88,033	107,810	42,6	--	S	++
Northern Lapwing	W Eur. / Med.	non-arctic	Benthos - Worm / Terrestrial	70,848	112,852	5,6	- (n.s.)	S	++ (n.s.)
Red Knot	trop. Afr. / W Eur.	arctic	Benthos - Shellfish	215,599	338,500	75,2	--	-	++ (n.s.)
Sanderling	trop. Afr. / W Eur.	arctic	Benthos - Worm	25,657	28,788	17,0	- (n.s.)	+	++ (n.s.)
Curlew Sandpiper	trop. Afr.	arctic	Benthos - Worm	9,017	10,717	1,4	--	(+)	
Dunlin	W Eur. / Med.	arctic	Benthos - Worm	814,509	1,384,306	106,5	--	S	++ (n.s.)
Ruff	trop. Afr.	arctic	Benthos - Worm	3,378	5,245	0,3	F	(-)	
Bar-tailed Godwit	trop. Afr. / W Eur.	arctic	Benthos - Worm	210,190	273,312	52,6	-	S	++ (n.s.)
Whimbrel	trop. Afr.	arctic	Benthos - Crustaceae / Frugivore	1,501	2,124	0,9	F	(+)	
Eurasian Curlew	W Eur.	non-arctic	Benthos	202,071	279,315	66,5	-	S	++ (n.s.)
Spotted Redshank	trop. Afr.	arctic	Benthos	14,205	18,814	18,8	-	S	
Common Redshank	trop. Afr. / W Eur.	non-arctic	Benthos	42,189	65,077	26,0	--	S	F
Common Greenshank	trop. Afr.	non-arctic	Benthos	12,777	18,759	6,1	-	S	
Ruddy Turnstone	trop. Afr. / W Eur.	arctic	Benthos	5,042	6,962	7,0	--	S	+ (n.s.)
Common Black-headed Gull	W Eur.	non-arctic	Generalist	337,953	498,834	24,9	F	+	+ (n.s.)
Common Gull	W Eur.	non-arctic	Generalist	177,143	197,624	11,6	F	+	++
Herring Gull	W Eur.	non-arctic	Benthos - Shellfish / Generalist	178,523	242,677	18,7	-- (n.s.)	-	++ (n.s.)
Great Black-backed Gull	W Eur.	non-arctic	Generalist	12,973	16,309	3,5	- (n.s.)	S	++

- eight species (24%) fluctuate too much for a trend to be estimated.

Overall long-term trends 1980-2000

- five species are decreasing, all of those also show short-term decreases (significant and not significant);
- eight species are increasing, all of those are either short-term increasing or fluctuating;
- 15 species are considered stable in the long-term; of those, 13 species are short-term decreasing (significant and not significant);
- for six species the long-term trend estimate is vague, because these species – namely Pintail, Shoveler, Kentish Plover, Ruff, Curlew Sandpiper and Whimbrel – utilize the Wadden Sea during short time periods and / or with very low fractions of their populations.

The alarming fact is that 44% of the species were decreasing during 1992-2000, including the not significant decreases, this adds up to 62%. Of those, three species – namely Mallard, Oystercatcher and Knot – also exhibit long-term decreases. The other species decreasing during 1992-2000 are categorized as long-term stable when looking at the period 1980-2000; thus, it is suggested that those might be short-term decreases of previously increasing populations. Only 9% of the species show an overall increase (Cormorant, Spoonbill and Barnacle Goose), an additional 6% show insignificant increases (Shelduck, Ringed Plover).

5.2.3.1 Analysis of potential factors influencing the trends of waterbirds in the Wadden Sea

Statistically significant trends might be artefacts, and vice versa, non-significant trends might be real. Eventually, each trend must be explained with ecological reasons (Underhill, 2003). Thus the question arises: what can we conclude from the trend analysis? For the trend of waterbirds species in the Wadden Sea area, possible factors are:

- wintering grounds,
- breeding grounds,
- food preferences in the Wadden Sea habitats,
- proportion of the flyway population,
- maximum number in the Wadden Sea.

Those factors have been compiled for each species in Table 5.3 and an analysis of the different factors has been compiled in Table 5.4.

Wintering grounds

Each species has been assigned one category of wintering ground. Since species with different wintering populations cannot be differentiated during the main migration periods in the Wadden Sea, this approach is justified.

	Results given as absolute species numbers						Results given as percentages				
Factors / values	**dec**	**dec (n.s.)**	**inc**	**inc (n.s.)**	**fluc**	**total**	**dec**	**dec (n.s.)**	**inc**	**inc (n.s.)**	**fluc**
OVERALL	15	6	3	2	8	34	44,1	17,6	8,8	5,9	23,5
Wintering grounds											
Trop. Afr.	3			1	2	6	50,0	0,0	0,0	16,7	33,3
Trop. Afr. / Med.	1		1		1	3	33,3	0,0	33,3	0,0	33,3
Trop. Afr. / W Eur	5	1				6	83,3	16,7	0,0	0,0	0,0
Trop. Afr – all	**8**	**1**	**0**	**1**	**2**	**12**	**66,7**	**8,3**	**0,0**	**8,3**	**16,7**
W. Eur.	5	2	1	1	3	12	41,7	16,7	8,3	8,3	25,0
W. Eur. / Med.	1	3	1		2	7	14,3	42,9	14,3	0,0	28,6
Breeding grounds											
Arctic	8	1	1	1	2	13	61,5	7,7	7,7	7,7	15,4
Non-arctic	7	5	2	1	6	21	33,3	23,8	9,5	4,8	28,6
Food preferences											
Benthos	5			1		6	83,3	0,0	0,0	16,7	0,0
Benthos worm	5	1		1	2	9	55,6	11,1	0,0	11,1	22,2
Benthos worm terr.					2	2	0,0	0,0	0,0	0,0	100,0
Benthos shell	2	1			1	4	50,0	25,0	0,0	0,0	25,0
Benthos shrimp			1			1	0,0	0,0	100,0	0,0	0,0
Benthos - crust - frug					1	1	0,0	0,0	0,0	0,0	100,0
Benthos – ALL	**12**	**2**	**1**	**2**	**6**	**23**	**52,2**	**8,7**	**4,3**	**8,7**	**26,1**
Fish			1			1	0,0	0,0	100,0	0,0	0,0
Generalist		1			2	3	0,0	33,3	0,0	0,0	66,7
Herbivor	2		1			3	66,7	0,0	33,3	0,0	0,0
Herbivor benthos	1	1			2	4	25,0	25,0	0,0	0,0	50,0
% Flyway population											
> 33 %	8		1	1		10	80,0	0,0	10,0	10,0	0,0
15 % - 33 %	3	4		1	3	11	27,3	36,4	0,0	9,1	27,3
< 15%	4	2	2		5	13	30,8	15,4	15,4	0,0	38,5
Max. number											
> 250,000	7		1		2	10	70,0	0,0	10,0	0,0	20,0
30,000 - 250,000	4	3		2	2	11	36,4	27,3	0,0	18,2	18,2
< 30,000	4	3	2		4	13	30,8	23,1	15,4	0,0	30,8

Table 5.4: List of different factors potentially affecting waterbird trends in the Wadden Sea. For each factors category the species number is given as well as the species number (left side) and percentage (right side) for each trend category. dec = decreasing; inc = increasing; fluc = fluctuating; n.s.= not significant.

Wintering in tropical Africa might enhance the chance for a "decrease", since the proportion of decreasing species is high within this group and lower in the species group wintering in Western Europe. In the latter group, however, the effect of the cold winters might have caused a higher winter mortality for two of the five decreasing species, namely the Wigeon and the Oystercatcher.

Breeding grounds

Of the 13 species having their breeding grounds in the Arctic, a high proportion show significant decreases. Thus, breeding in the Arctic may be a reason for a decrease. Also, 10 of 13 arctic breeding species have populations wintering in tropical Africa. Thus, the risk of a decrease might be enhanced for those long-distance migrants.

Food preferences in the Wadden Sea habitats

The factor of food preferences consists of numerous categories, and among the benthos feeders alone several species groups are found. However, benthos feeding waders have a high proportion of decreasing species; with the exception of Ringed and Kentish Plover (both short-billed waders picking from the surface rather than probing) and Ruff (high proportions outside Wadden Sea habitats), all of them (14) are decreasing significantly or not significantly.

Proportion of the flyway population

Those species which utilize the Wadden Sea with high proportions of their flyway population are especially vulnerable to changes in the Wadden Sea. Of the 10 species with more than 33% of their largest flyway populations in the Wadden Sea, eight (80%) are decreasing. The only increasing species in this group, Barnacle Goose, might evade this problem by utilizing inland feeding areas (see Koffijberg and Günther, 2005, this volume).

Maximum number in the Wadden Sea

Closely related to the previous parameter, of the 10 species with more than 250,000 individuals in the Wadden Sea at their peak time, seven (70%) are decreasing. Of the three others, Barnacle Goose is again the only increasing species, and Eider and Black-headed Gull both have no overall trend estimate.

5.2.3.2 Trend results per species or species groups

Decreasing species

Dark-bellied Brent Goose and **Wigeon,** both herbivorous species, are both decreasing during all relevant seasons; however, both species saw a considerable increase during the previous decade. It seems clear that after the long increase of Brent Geese until 1996, low reproduction rates (breeding success) have led to a decline in overall numbers, which is also observed in France (Deceuninck and Maheo, 2000). For Wigeon, the flyway population seems to stay on a high level; thus, winter mortality and maybe some habitat effects might cause their decline within the Wadden Sea.

Mallard shows both short and long-term decreases. None of the potential factor seems to play a role, and so this decrease cannot be explained by the factors mentioned above. However, a decrease is reported for the international flyway population (Wetlands International, 2002) and also for the UK (Austin *et al.*, 2003).

Eurasian Oystercatcher and **Red Knot** also both show short and long-term decreases. They are both benthos and bivalve feeders: the trend in Oystercatcher applies for all seasons. Ecological reasons might be food limitations (see Scheiffarth and Frank, 2005, this volume); both species occur in high numbers and represent high proportions of their respective flyway populations, pointing to the fact that the carrying capacity in the Wadden Sea might cause some problems. The Knot also bears the additional risks of being a long-distance migrant.

Grey Plover, Curlew Sandpiper, Dunlin, Bar-tailed Godwit, Common Greenshank and **Ruddy Turnstone** are all benthos-worm feeders and long-distance migrants, thus depending on the Wadden Sea to a great degree. Of those, Grey Plover, Dunlin and Bar-tailed Godwit occur in very high numbers and represent high proportions of their flyway populations. None of these species shows decreases at flyway level (Wetlands International, 2002). Grey Plover, Bar-tailed Godwit and Turnstone show increases in winter numbers in France (Deceuninck and Maheo, 2000).

Pied Avocet, Eurasian Curlew and **Common Redshank** are all benthos-worm feeders, but not long-distance migrants; Avocet and Curlew occur with high proportions of their flyway populations, however these are either stable or increasing (Wetlands International, 2002). The Redshank has increasing numbers in France (Deceuninck and Maheo, 2000)

Increasing species

Both **Cormorant** and **Spoonbill** are food specialists, the Cormorant feeding mainly on fish and the Spoonbill also feeding on benthos and shrimp. Their increases must be seen in light of population increases and/or distribution shifts; for the Spoonbill, this applies for the small West-European population (Wetlands International, 2002; Bregnballe *et al.*, 2003).

Barnacle Goose is a herbivorous species, an arctic breeder, and occurs in high numbers with high proportions of the flyway population. The increase goes along with an increase of the Russian-Baltic flyway population and a prolonged stay in the Wadden Sea habitats (see Koffijberg and Günther, 2005, this volume).

Conclusion: A look at the individual species and species groups offers some explanations for increases or decreases with regard to the entire Wadden Sea. However, each species would deserve a more detailed analysis itself and also in more regional approaches within the Wadden Sea, a task which is outside the scope of this report.

5.2.4 Trends – synthesis and conclusions

Of the 34 species which have been considered here, 15 species (44% out of 34 species considered) experienced significant decreases in the 1990s, including the not significant decreases this adds up to 21 species (62%) (Table 5.4). This is an alarming finding, since among those are species for which more than 50% of the total flyway population migrate through or stay within the Wadden Sea (Figure 5.1), and thus species for which the Wadden Sea countries have a particular responsibility. Many of the declining species have in common that they are long-distance migrants and their lifetime strategy includes periods of fast re-fuelling of body reserves in the Wadden Sea en route to their high arctic breeding areas or African wintering sites. Since the declining numbers for most of these species have not been confirmed elsewhere in Europe (*e.g.* UK, Austin *et al.*, 2003; France, Deceunick and Maheo, 2000), the underlying causes for the downward trends are assumed to be connected to the situation in the Wadden Sea (Davidson, 2003). Declines in the entire Wadden Sea have also been reported for the breeding population of resident species such as Eurasian Oystercatcher and at a local scale for Avocet and Herring gull (Koffijberg *et al.*, 2005; Dijksen *et al.*, in prep.), of which major parts of the population stay in the Wadden Sea after the breeding season.

The causes of the observed population declines are not known in detail for all species, and cannot be assessed by monitoring alone. At least for Dark-bellied Brent Goose, there is a clear relationship with poor breeding seasons (see Koffijberg and Günther, 2005, this volume). For several benthos-specialists (*e.g.* Eider, Oystercatcher, but maybe also Knot and Herring Gull), there is evidence that food availability has deteriorated in the past decades (Ens *et al.*, 2004, Scheiffarth and Frank, 2005, this volume). Most of the other declining species are also benthos-feeders. More ecological research is needed to understand and reverse the negative trends which have been detected (Essink *et al.*, 2005).

Compared to the numerous species showing declines, rather few species show significant upward overall trends. These are Cormorant, Spoonbill and Barnacle Goose, all species which have been experiencing increases of their respective flyway populations in the past decade (Wetlands International, 2002).

5.3 Data exchange and analysis

5.3.1 Data exchange

For this report each country was requested to send raw data from all counting units. For this purpose a simple "data exchange format" was designed, which proved to be successful and will be used and further implemented in the future. Thus, it is not recommended to install a common "Wadden Sea Database", since modifications and continuous corrections at the national and regional levels are unavoidable. It is worthwhile to investigate if raw data from the period 1980-1991 can be used in the same way as that from 1992 onwards, as then trend calculations can be performed for a longer time-period. For this goal the older data should be available in the national databases in the same way as from 1992 onwards and different types of counts (international synchronous counts, spring tide counts, aerial counts and additional counts from national monitoring schemes) should be combined into one dataset which relates to the same counting units and enables analyses in an integrated way.

In this respect too the definition of the study area is very important. In general the Wadden Sea Area is included and all counting units within this area are part of the monitoring program. Discussion remains on the number of inland sites which need to be incorporated as they are used by populations of waterbirds directly linked to the Wadden sea. Examples are Barnacle Geese and Brent Geese feeding inland, Golden Plover, Northern Lapwing, Ruff and Eurasian Curlew using habitats close to the coast or further inland.

5.3.2 Data analyses

Some choices made for the analyses in this report are discussed below and recommendations for the future are formulated.

There will always be missing counts in waterbird counting schemes. The choice of the program to account for missing values has been a topic of many debates and publications. The same is true for the way to calculate trends (*e.g.* ter Braak *et al.* 1994; Underhill and Prys-Jones 1994; Kershaw *et al.* 1998; Kershaw and Cranswick, 2003; Rehfisch *et al.* 2003; Soldaat *et al.*, 2004). For this report we used TRIM, which enables imputing and trend analysis at the same time. However other possibilities exist and maybe in the future methods will change as the level of knowledge and available programs increases. Some points of consideration are listed here.

5.3.2.1 Statistical program

Today, two programs, UINDEX (Bell, 1995) and TRIM (Pannekoek and van Strien, 2001), are tailored to fulfill the needs of migratory bird time series data and are – with some limitations – easy to handle and do not require too much computer power. Currently, national and international institutions apply those, so that the results are valid for comparisons between countries and regions (*e.g.* van Strien *et al.* 2001). UINDEX imputes missing values while incorporating the seasonal pattern of the species involved but lacks a formal trend analyses procedure. TRIM does not incorporate the seasonal pattern and analyses need to be performed on individual months, but it has a formal trend analysis procedure. Proposals have been put forward to use both programs (Soldaat *et al.*, 2004) in which the imputing of missing values is carried out by UINDEX and the trend analyses by TRIM. However, this still gives no proper estimation of the confidence limits, which is at present one of the difficult issues in the monitoring of migratory waterbirds. Some institutions (*e.g.* BTO) have used more sophisticated software (Generalized additive models - GAM) for trend analyses which is worth investigating in the future.

5.3.2.2 Time periods for trend analyses

Many choices can be made about the period of the year to analyze for trends. Clearly, the January trends within the Wadden Sea are considerably influenced by the weather pattern. However on an international level the January counts are indispensible for monitoring flyway-populations, which is carried out by Wetlands International. With regard to the Wadden Sea it is also important to look at periods of peak migration in autumn and spring. Alternatively (or in addition), one may look at the entire usage of the Wadden Sea expressed during one yearly cycle. Within this report (and partly due to the limitations of the program TRIM in only analyzing one datapoint per year), it has been decided to use data from one or several months of peak occurrence for most trend analyses. To look at the overall usage of the Wadden Sea during the entire yearly cycle, all monthly results have been used in the discussion in this report. The possibilities – including a program to account for missing values and calculate trends - of using more or all months of the year for trend analyses and expressing them as estimates of "bird days" spent, need to be investigated for the future.

5.3.2.3 Covariates

For this report, it has not been tried to incorporate covariates in the trend analyses. The imputing of missing values has been carried out within the Wadden Sea as a whole. However, trends reported in separate countries or regions, e.g. The Netherlands (van Roomen *et al.*, 2004), Niedersachsen and Schleswig-Holstein (Günther, 2003; Blew *et al.*, in prep.) and Denmark (Laursen and Frikke, in prep.) are in some cases different from the international Wadden Sea trend. So the need to incorporate country, region or habitat as a covariate for further analyses needs to be investigated.

5.3.2.4 Alert systems

In the UK (Austin *et al.*, 2003) a so-called 'Alert-System' has been installed. A similar system is under discussion in The Netherlands (Nobel *et al.*, 2002). By monitoring numbers and above all trends, a series of alerts can be triggered when a species shows considerable declines. Alerts in the UK have been installed for nationwide numbers and trends (national alerts), but also for each region/site (site alerts). A system of short-term (5-year), medium-term (10-years) and long-term (25 years) alerts exist with two levels, a 'Medium Alert', if population declines are between 25% and 50% in the time period considered, and a 'High Alert', if they are greater than 50%. The calculation of these alerts depends on fitting a smoothed trend curve through the calculated index values. To avoid over-interpretation of non-existing trends or missing existing but concealed trends, a system of species-specific "biological filters" is applied, accounting for particular fluctuation patterns of some species, longevity of species, site faithfulness within winter or between migration periods. This system can have widespread application and recognition, especially since suggestions have been made to link it to the goals and practical guidelines of the IUCN Red Data Lists (Nobel *et al.*, 2002), so the application within the Wadden Sea seems worthwhile considering.

5.4 Implementation of the JMMB Program

In general, the JMMB program has proved to be successful. For the first time trends could be calculated and new estimates of numbers present at the end of the 1990s could be provided for the entire Wadden Sea area. The **international synchronous counts in January,** indispensable for the estimation of and comparison with international population numbers, are generally well covered (Figure 3.1). The **international synchronous counts in months other than January** have added highly valuable information about many species during their migration periods (Table 2.5); almost all of those additional internationally synchronous counts yielded – in comparison to other nationally organized counts - both the highest counted numbers and the lowest proportion of imputed numbers (Figure and many examples in species accounts); this is a valuable proof that not only the site coverage, but also the "species coverage" has been very good during the synchronous counts (see Chapter 3.2).

The estimates of maximum numbers in the international Wadden Sea update the report of Meltofte *et al.*, (1994). However, with regard to the calculation of trends, a modified approach of the original plan (Rösner,1993) has been followed in the present report. At the start of the JMMB program in 1994, the idea was to base the trends only on the results of the spring tide counting sites. Good results have been achieved with this method in Schleswig-Holstein, where 24 spring tide counting sites with a total of 33 counting units exist, covering a considerable proportion of this Wadden Sea region (Rösner, 1994; Günther, 2003). In the other regions, however smaller proportions of the area are represented by spring tide counting sites and doubts were expressed about the representativity of results based on this limited selection of sites (Poot *et al.*, 1996). For The Netherlands it was concluded that their own spring tide counting sites were not representative enough to be used as the only basis for monitoring the Dutch Wadden Sea (Willems *et al.*, 2001). Also in Niedersachsen, for most species the results of the spring tide counting sites do not correctly reflect the population development in the region (Blew and Südbeck, pers. comm.). Thus, the assumption that the spring tide counting sites yield representative results for the entire Wadden Sea could not be substantiated. Moreover, at present there is no program available to conduct imputing of missing values with 25 counts per year at non-fixed counting dates. Nonetheless, the ultimate goal for the trend calculation is to base these on yearly and seasonal estimates of bird-days per species.

For this report, we decided to use all the data available to estimate numbers present per months in the entire Wadden Sea area. By using TRIM software, imputing and trend calculation could be conducted for individual months. By assessing the estimates of individual months for each season we obtained estimates of bird use per season. Overall trends were analyzed by summing up the results of all available months and fitting a linear regression through those. The data used consisted of the international synchronous counts in January, the international synchronous counts in months **other** than January, the international spring tide counts and any other additional national counting data. In this way, all data of the JMMB program was used in this analysis and supplemented with national data. This approach has also its weaknesses, which need investigation in the future. Important discussion points are a possible decrease in the accuracy of the estimation of the year-round utilization of the Wadden Sea per species through using only one count per month instead of two; this will especially be important for species with short peak occurrences (*e.g.* Curlew Sandpiper, Spotted Redshank).

Secondly, considerable imputing of missing counts was sometimes necessary to reach an estimate of numbers present in a certain month. Thus, the current levels of counting coverage need at least to be continued (including the additional national counting programs) and it should be investigated if organizing extra international synchronous counts is feasible and necessary, in particular, for months with regular high numbers of migrating birds such as August and September in autumn and especially May in spring. In The Netherlands, such an investigation concluded that a program of three to five synchronous counts together with monthly counts in a selection of sites was able to calculate accurate trends for most important species in the Dutch Wadden Sea (van Roomen *et al.*, 2002).

The continuation of aerial counts for Common Eider and Common Shelduck during their staging and moulting periods will remain indispensable in order to correctly cover these species. Also, the special goose counts yield valuable results. For special purposes additionally organized counts can deliver interesting aspects, for example the counts of Sanderling at the end of May.

Equally important will be to compile and analyze population developments of species in other countries of their flyway in order to detect true population trends and potentially reveal mere distribution shifts within the flyway.

The NATURA 2000 network is subject to the trilateral Wadden Sea policy and activities. A sound monitoring program for migratory birds as part of the TMAP fulfils obligations towards monitoring and reporting for the EU Birds Directive (Council Directive 79/409 EEC of 1979 on the Conservation of wild birds) (*e.g.* Fels 2001a/b). For the implementation of the Water Framework Directive (WFD), a close cooperation with regard to the Wadden Sea Area has been expressed at the Trilateral Governmental Conference in Esbjerg 2001 and at the TMAP WFD workshop on "Reference Values in the Wadden Sea Cooperation" in November 2004. The "good ecological status" regarding favorable conservation status for the Wadden Sea also requires fine tuning of the current monitoring programs with regard to sampling sites, frequencies and methods but also data processing, assessment procedure and reporting. The development of monitoring strategies for the Water Framework Directive is currently under way in all three Wadden Sea states and must be operational by the end of 2006 (Marencic and Essink, 2004).

By now, we are able to produce sound results regarding the population status of waterbird species ecologically belonging to the international Wadden Sea and thus can fulfill obligations deriving from the European directives mentioned above. Trend analysis methods can be refined to produce even more reliable results; equally important is that monitoring programs continue to exist over long time periods to provide data for the continuation of trend estimates. Monitoring programs must ensure that data exchange, comparison and causal analyses are possible including other species groups and ecological parameters in order to further describe and understand the favorable conservation status for the international Wadden Sea.

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Annex 1: Counting Units and STC-Sites

List of counting units and spring tide counting sites (STC-sites) sorted by country and national site code

All national site codes respectively the STC-site codes printed in bold in the list can also be found in Figure 2.1.

Country	National site code	Name of counting unit	Spring tide counting site	Name of spring tide counting site
DK	01B	Magisterkogen m.v.	**DK 05**	Margrethe-Kog
DK	02B	Tøndermarsken Indre Koge	DK 05	Margrethe-Kog
DK	03B	Tøndermarsken Ydre Koge	DK 05	Margrethe-Kog
DK	04D	Dagligreservoiret	DK 05	Margrethe-Kog
DK	04K	Margrethe-Kog græsareal	DK 05	Margrethe-Kog
DK	04N	Margrethe-Kog N	DK 05	Margrethe-Kog
DK	04S	Saltvandssøen	DK 05	Margrethe-Kog
DK	05	Emmerlev Klev		
DK	06	Margrethe-Kog Forland N	DK 05	Margrethe-Kog
DK	07	Margrethe-Kog Forland S	DK 05	Margrethe-Kog
DK	08	Højer Dyb		
DK	11	Koldby		
DK	12	Jordsand Flak		
DK	13	Jordsand		
DK	14	Lister Dyb S		
DK	15	Sønderstrand		
DK	15B	Havneby Kog		
DK	16	Lister Dyb Nord		
DK	16B	Havsand Syd		
DK	22	Ballum Forland		
DK	22B	Ballum Enge		
DK	22C	Ålebjerg Enge		
DK	23	Kongsmark		
DK	24	Rømødæmningen SØ		
DK	25	Rømødæmningen SV		
DK	26B	Mølby		
DK	27B	Lakolk Sø		
DK	28	Vesterhavet, Havsand		
DK	28B	Havsand		
DK	29B	Toftum		
DK	30	Vesterhavet, Rømø Vesterstrand		
DK	30B	Rømø Vesterstrand		
DK	31	Rømødæmningen NØ		
DK	31B	Astrup Enge		
DK	32	Rømødæmningen NV		
DK	33	Juvre		
DK	33B	Juvre Enge		
DK	34	Rejsby Forland		
DK	34B	Rejsby Enge		
DK	35	Brøns forland		
DK	35B	Brøns Enge		
DK	36	Råhede Vade		
DK	36B	Hvidding Enge		
DK	37	Mandø SØ		
DK	38	Rejsby Stjert		
DK	39	Juvre Dyb		
DK	39B	Rømø Skydeområde		
DK	40	Koresand		
DK	40B	Mandø Bykog		

Country	National site code	Name of counting unit	Spring tide counting site	Name of spring tide counting site
DK	50	Mandø Låningsvej	**DK 04**	Indvindingen
DK	53	Kammerslusen	DK 04	Indvindingen
DK	53B	Ribemarsken	DK 04	Indvindingen
DK	54	Kongeåen Forland		
DK	54B	Hillerup Enge		
DK	55	Peelrev	DK 04	Indvindingen
DK	55B	Søndre Farup	DK 04	Indvindingen
DK	56	Keldsand	**DK 03**	Fano South
DK	57	Mandø Flak N		
DK	57B	Gammel Mandø Kog		
DK	58	Mandø Flak V		
DK	59	Fanø Sønderstrand	DK 03	Fano South
DK	60	Peter Meyers Sand	DK 03	Fano South
DK	61	Fanø Vestertrand S	DK 03	Fano South
DK	63	Trinden	DK 03	Fano South
DK	64	Albuebugten	DK 03	Fano South
DK	65	Pendersand	DK 03	Fano South
DK	66	Sneum Vade		
DK	66B	Sneum Enge		
DK	67	Tjæreborg Vade		
DK	67B	Tjæreborg Enge		
DK	67C	Måde Enge		
DK	68	Halen	**DK 02**	Fano North
DK	69	Søjord	DK 02	Fano North
DK	70	Esbjerg Havn S		
DK	71	Fanø Vestertrand N	DK 02	Fano North
DK	81	Grønningen Fanø	DK 02	Fano North
DK	83	Esbjerg Havn N		
DK	84	Grådyb		
DK	85	Grådyb Barre		
DK	86	Skallingen Vesterstrand		
DK	87	Hvidbjerg og Blåvand Strand		
DK	91	Langli Flak	**DK 01**	Langli
DK	92	Langli V	DK 01	Langli
DK	93	Hobo Dyb	DK 01	Langli
DK	93B	Skallingen S		
DK	93C	Skallingen N		
DK	94	Topsand		
DK	95	Langli Ø og Langli	DK 01	Langli
DK	97	Ebbevejen	DK 01	Langli
DK	98	Myrtue		
DK	99	Ho Bugt		
DK	99B	Ho Bugt Enge		
DK	99D	Grønningen Skallingen		
SH	**IS1**1	Sylt, West, Ellenbogen bis Kurstrandhalle		
SH	IS12	Sylt, West, Kurstrandhalle bis Klappholttal		
SH	IS13	Sylt, West, Klappholttal bis Wenningstedt-Nord		
SH	IS14	Sylt, West, Wenningstedt-Nord bis Westerland		
SH	IS15	Sylt, West, Westerland bis Rantum		
SH	IS16	Sylt, West, Rantum bis Puan Klent		
SH	IS17	Sylt, West, Puan Klent bis Tetrapoden		
SH	IS18	Sylt, West, Hörnumer Odde bis Hafen Hörnum		
SH	**IS2A**	Sylt, Königshafen (IS2) & Lister Koog (IS62)	SH 01	Sylt, Königshafen & Lister Koog
SH	**IS3**1	Sylt, List Hafen bis Kampener Vogelkoje		
SH	IS32	Sylt, Kampener Vogelkoje bis Munkmarsch Hafen	SH 02	Sylt, List bis Morsum
SH	IS33	Sylt, Munkmarsch Hafen bis Keitum Tipkenhügel	SH 02	Sylt, List bis Morsum

Country	National site code	Name of counting unit	Spring tide counting site	Name of spring tide counting site
SH	IS34	Sylt, Anwachs Archsum	SH 02	Sylt, List bis Morsum
SH	IS35	Sylt, Morsum bis Hindenburgdamm	SH 02	Sylt, List bis Morsum
SH	IS41	Sylt, Morsum bis Sandinseln	SH 03	Sylt, Morsum Odde bis Rantumbecken
SH	IS42	Sylt, Sandinseln	SH 03	Sylt, Morsum Odde bis Rantumbecken
SH	IS46	Sylt, Rantumbecken	SH 03	Sylt, Morsum Odde bis Rantumbecken
SH	IS44	Sylt, Hörnumer Nehrung	SH 04	Sylt, Rantum bis Hörnumer Hafen
SH	IS43	Sylt, Rantum bis Hörnumer Nehrung	SH 04	Sylt, Rantum bis Hörnumer Hafen
SH	IS45	Sylt, Hörnumer Nehrung bis Hafen	SH 04	Sylt, Rantum bis Hörnumer Hafen
SH	IS61	Sylt, Marschen Ost		
SH	IA11	Amrum, Salzwiesen-Vorland	SH 05	Amrum, Salzwiesen und Kniepsand
SH	IA12	Amrum, Salzwiesen-Vorland	SH 05	Amrum, Salzwiesen und Kniepsand
SH	IA13	Amrum, Salzwiesen-Vorland	SH 05	Amrum, Salzwiesen und Kniepsand
SH	IA14	Amrum, Salzwiesen-Vorland	SH 05	Amrum, Salzwiesen und Kniepsand
SH	IA61	Amrum, Norddorfer Marsch	SH 05	Amrum, Salzwiesen und Kniepsand
SH	IA62	Amrum, Wittdüner Marsch	SH 05	Amrum, Salzwiesen und Kniepsand
SH	IA2	Amrum, Kniepbucht	SH 05	Amrum, Salzwiesen und Kniepsand
SH	IA31	Amrum, Kniepsand Nord	SH 05	Amrum, Salzwiesen und Kniepsand
SH	IA32	Amrum, Kniepsand Süd		
SH	IA4	Amrumer Odde		
SH	IF11	Föhr, Salzwiesen-Vorland Nord, Sörensvai	SH 06	Föhr, Nordküste
SH	IF12	Föhr, Salzwiesen-Vorland Nord, Oldsum	SH 06	Föhr, Nordküste
SH	IF13	Föhr, Salzwiesen-Vorland Nord, Midlum	SH 06	Föhr, Nordküste
SH	IF411	Föhr, Schardeich Ost	SH 06	Föhr, Nordküste
SH	IF31	Föhr, Godelniederung	SH 07	Föhr, Godel- & Brukniederung
SH	IF32	Föhr, Brukniederung	SH 07	Föhr, Godel- & Brukniederung
SH	IF412	Föhr, Schardeich Ost	SH 08	Föhr, Südostküste
SH	IF52	Föhr, Marschen Ost	SH 08	Föhr, Südostküste
SH	IF2	Föhr, Schardeich West		
SH	IF42	Föhr, Außendeich Südost		
SH	IF51	Föhr, Marschen Nordwest		
SH	IF53	Föhr, zentrale Marschen		
SH	IF6A	Föhr, Geest West		
SH	IF6B	Föhr, Geest Ost		
SH	IH111	Langeneß, Ridd im Westen	SH 09	Hallig Langeness, Salzwiesen-Vorland & Ridd
SH	IH12	Langeneß, Salzwiesen-Vorland im Osten	SH 09	Hallig Langeness, Salzwiesen-Vorland & Ridd
SH	IH13	Langeneß, Wasserflächen		
SH	IH1C	Langeneß, Halligfläche West, ohne Ridd		
SH	IH1D	Langeneß, Halligfläche Ost		
SH	IH2	Oland, Halligfläche		
SH	IH2	Oland, Salzwiesen-Vorland		
SH	IH3	Gröde		
SH	IH4	Habel		
SH	IH5	Nordstrandischmoor		
SH	IH61	Hooge, Osten	SH 10	Hallig Hooge
SH	IH62	Hooge, Westen	SH 10	Hallig Hooge
SH	IH7	Norderoog		
SH	IH8	Süderoog	SH 11	Hallig Süderoog
SH	IH9	Südfall	SH 12	Hallig Südfall
SH	IP11	Pellworm, Salzwiesen-Vorland, Buphever Koog	SH 13	Pellworm, Salzwiesen und Schardeich West
SH	IP12	Pellworm, Salzwiesen-Vorland, Junkernhallig	SH 13	Pellworm, Salzwiesen und Schardeich West
SH	IP13	Pellworm, Salzwiesen-Vorland, Hökhallig	SH 13	Pellworm, Salzwiesen und Schardeich West
SH	IP2A	Pellworm, Schardeich West	SH 13	Pellworm, Salzwiesen und Schardeich West
SH	IP41	Pellworm, Waldhusentief	SH 13	Pellworm, Salzwiesen und Schardeich West
SH	IP2B	Pellworm, Schardeich Ost		
SH	IP3	Pellworm, Marschen		
SH	IP42	Pellworm, Süderkoogstief		
SH	IP45	Pellworm, Pütten		

Country	National site code	Name of counting unit	Spring tide counting site	Name of spring tide counting site
SH	IP46	Pellworm, Alter Priel im Bupheverkoog		
SH	**SN1**	Japsand		
SH	**SN2**	Norderoogsand		
SH	**SN3**	Süderoogsand		
SH	**FN1**	Rickelsbüller Koog	SH 14	Rickelsbüller Koog & Salzwiesen-Vorland
SH	**VN1**	Rickelsbüller Koog Salzwiesen-Vorland	SH 14	Rickelsbüller Koog & Salzwiesen-Vorland
SH	**VN2**1	Syltdamm bis Südwesthörn	SH 15	Lübke- & Marienkoog Salzwiesen-Vorland
SH	VN22	Südwesthörn bis Dagebüll	SH 15	Lübke- & Marienkoog Salzwiesen-Vorland
SH	**FN2**	Fahretofter Koog	SH 16	Fahretofter Koog & Salzwiesen-Vorland
SH	**VN3**1	Dagebüll bis Schlüttsiel, Nord Olanddamm	SH 16	Fahretofter Koog & Salzwiesen-Vorland
SH	VN32	Dagebüll bis Schlüttsiel, Salzwiesen-Vorland	SH 16	Fahretofter Koog & Salzwiesen-Vorland
SH	VN33	Dagebüll bis Schlüttsiel, Schardeich	SH 16	Fahretofter Koog & Salzwiesen-Vorland
SH	**FN3**1	Hauke-Haien-Koog, Nordbecken	SH 17	Hauke-Haien-Koog
SH	FN32	Hauke-Haien-Koog, Mittelbecken	SH 17	Hauke-Haien-Koog
SH	FN33	Hauke-Haien-Koog, Südbecken	SH 17	Hauke-Haien-Koog
SH	**FN4**	Ockholmer Koog	SH 18	Ockholmer Koog & Salzwiesen-Vorland
SH	**VN4**1	Schlüttsiel bis Hamburger Hallig, Schardeich	SH 18	Ockholmer Koog & Salzwiesen-Vorland
SH	VN42	Schlüttsiel bis Hamburger Hallig, Salzwiesen-Vorland	SH 18	Ockholmer Koog & Salzwiesen-Vorland
SH	**VN5**1	Hamburger Hallig, West	SH 19	Hamburger Hallig & Sönke-N. Koog Vorland
SH	VN52	Hamburger Hallig, Nord	SH 19	Hamburger Hallig & Sönke-N. Koog Vorland
SH	VN53	Hamburger Hallig, Süd	SH 19	Hamburger Hallig & Sönke-N. Koog Vorland
SH	VN54	Hamburger Hallig, Ost	SH 19	Hamburger Hallig & Sönke-N. Koog Vorland
SH	**VN6**1	Salzwiesen-Vorland südlich Hamburger Hallig	SH 19	Hamburger Hallig & Sönke-N. Koog Vorland
SH	VN62	Beltringharder Koog, Außendeich Nord	SH 19	Hamburger Hallig & Sönke-N. Koog Vorland
SH	VN63	Beltringharder Koog, Außendeich, Süd		
SH	**FN6**1	Beltringharder Koog, Sönke-N.-Koog Speicherbecken	SH 20	Beltringharder Koog
SH	FN62	Beltringharder Koog, Lüttmorrsee	SH 20	Beltringharder Koog
SH	FN63	Beltringharder Koog, Kleientnahmen Nord & Süd	SH 20	Beltringharder Koog
SH	FN64	Beltringharder Koog, Salzwasserlagune Nord & Süd	SH 20	Beltringharder Koog
SH	FN65	Beltringharder Koog, Wiese Ost	SH 20	Beltringharder Koog
SH	FN66	Beltringharder Koog, Arlau Speicherbecken	SH 20	Beltringharder Koog
SH	FN67	Beltringharder Koog, Holmer See	SH 20	Beltringharder Koog
SH	**VN7**1	Nordstrand, Holmer Siel bis Strucklahnungshörn		
SH	VN72	Nordstrand, Strucklahnungshörn bis Dreisprung	SH 21	Nordstrand, Salzwiesen-Vorland
SH	**VN8**1	Nordstrand, Salzwiesen-Vorland SW von Süderhafen	SH 21	Nordstrand, Salzwiesen-Vorland
SH	VN82	Nordstrand, Pohnshalligkoog Salzwiesen-Vorland	SH 21	Nordstrand, Salzwiesen-Vorland
SH	**VN9**1	Schobüller Bucht, Nordstrander Damm	SH 22	Husum bis Nordstrand, Salzwiesen-Vorland
SH	VN92	Schobüller Bucht, Schobüll	SH 22	Husum bis Nordstrand, Salzwiesen-Vorland
SH	VN93	Schobüller Bucht, Dockkoog	SH 22	Husum bis Nordstrand, Salzwiesen-Vorland
SH	**FE1**	Finkhaushallig Speicher	SH 23	Husum bis Tetenbüllspieker
SH	**FE2**	Westerspätinge	SH 23	Husum bis Tetenbüllspieker
SH	**VE1**1	Husum bis Finkhaushallig	SH 23	Husum bis Tetenbüllspieker
SH	VE12	Finkhaushallig bis Simonsberg	SH 23	Husum bis Tetenbüllspieker
SH	VE13	Simonsberg bis Tetenbüllspiker	SH 23	Husum bis Tetenbüllspieker
SH	**FE3**	Tetenbüllspieker	SH 24	Norderheverkoog & Tetenbüllspieker
SH	**VE2**1	Norderheverkoog Salzwiesen-Vorland, Ost	SH 24	Norderheverkoog & Tetenbüllspieker
SH	VE22	Norderheverkoog Salzwiesen-Vorland, West	SH 24	Norderheverkoog & Tetenbüllspieker
SH	**VE3**1	Westerhever Sandbank	SH 25	Westerhever, Vorland und Sandbank
SH	VE321	Westerhever Salzwiesen-Vorland, Nord	SH 25	Westerhever, Vorland und Sandbank
SH	VE322	Westerhever Salzwiesen-Vorland, Süd	SH 25	Westerhever, Vorland und Sandbank
SH	**VE4**1	Tümlauer Bucht, Nord		
SH	VE42	Tümlauer Bucht, Ost		
SH	VE43	Tümlauer Bucht, Süd		
SH	**FE5**1	Brösumer Spätinge, Marschen		

Country	National site code	Name of counting unit	Spring tide counting site	Name of spring tide counting site
SH	FE52	Brösumer Spätinge, Teiche		
SH	**VE51**	St.Peter, Sandbank & Vorland, Nord		
SH	**VE52**	St.Peter, Sandbank & Vorland, Nordwest		
SH	**VE53**	St.Peter, Sandbank & Vorland, Südwest		
SH	**VE54**	St.Peter, Sandbank & Vorland, Süd	SH 26	St. Peter Sandbank, Südspitze
SH	**FE6**	St.Peter, südliche Teiche		
SH	**FE7**	St.Peter, Teiche bei Südwesthörn		
SH	**VE6**1	St.Peter bis Eider-Ästuar, Ehsterkoog	SH 27	St. Peter bis Eider-Ästuar
SH	VE62	St.Peter bis Eider-Ästuar, Grothusenkoog	SH 27	St. Peter bis Eider-Ästuar
SH	VE63	St.Peter bis Eider-Ästuar, Vollerwiek	SH 27	St. Peter bis Eider-Ästuar
SH	**EE1**1	Eider-Ästuar, Katinger Watt, Olversumer Vorland, Ost	SH 28	Eider Ästuar, Katinger Watt
SH	EE12	Eider-Ästuar, Katinger Watt, Olversumer Vorland, West	SH 28	Eider Ästuar, Katinger Watt
SH	EE13	Eider-Ästuar, Katinger Watt, Feuchtgebiet am Leitdamm	SH 28	Eider Ästuar, Katinger Watt
SH	EE14	Eider-Ästuar, Katinger Watt, östlich Seedeich bis Katinger Priel	SH 28	Eider Ästuar, Katinger Watt
SH	EE15	Eider-Ästuar, Katinger Watt, Ackerflächen	SH 28	Eider Ästuar, Katinger Watt
SH	**EE2**B	Eider-Ästuar, Eider Südufer, West		
SH	EE2C	Eider-Ästuar, Eider Südufer, Ost		
SH	**EE3**	Eider-Ästuar, Eider Wattflächen		
SH	**EE4**1	Eider-Ästuar, Oldensworter Vorland		
SH	EE42	Eider-Ästuar, Lundener Vorland		
SH	EE43	Eider-Ästuar, Eider östlich Friedrichstadt		
SH	**FD4**	Schülperneuensiel		
SH	**FD3**	Hedwigenkoog Speicherbecken	SH 29	Hedwigenkoog Salzwiesen-Vorland
SH	**VD11**	Hedwigenkoog Salzwiesen-Vorland	SH 29	Hedwigenkoog Salzwiesen-Vorland
SH	**VD12**	Schardeich Hedwigenkoog bis Büsum		
SH	**SD1**	Blauortsand		
SH	**FD1**1	Meldorfer Koog, Nord, NSG Wöhrdener Loch	SH 30	Meldorfer Koog & Helmsand
SH	FD1A	Meldorfer Koog, Nord, Miele Speicherbecken	SH 30	Meldorfer Koog & Helmsand
SH	FD1B	Meldorfer Koog, Nord, NSG Kronenloch	SH 30	Meldorfer Koog & Helmsand
SH	FD1C	Meldorfer Koog, Nord, Ackerflächen Ost	SH 30	Meldorfer Koog & Helmsand
SH	**FD2**	Meldorfer Koog, Süd	SH 30	Meldorfer Koog & Helmsand
SH	**VD21**	Büsum bis Meldorf Hafen	SH 30	Meldorfer Koog & Helmsand
SH	**VD22**	Meldorf Hafen bis Helmsand	SH 30	Meldorfer Koog & Helmsand
SH	**IT**	Trischen	SH 31	Trischen
SH	**VD3**	Friedrichskoog, Salzwiesen-Vorland Nord	SH 32	Friedrichskoog, Salzwiesen-Vorland Nord
SH	**FD7**	Rugenorter Loch		
SH	**VD41**	Dieksanderkoog, Salzwiesen-Vorland Nord		
SH	**VD42**	Dieksanderkoog, Salzwiesen-Vorland Süd		
SH	**FD8**	Dieksanderkoog, Alter Priel binnendeichs		
SH	**VD51**	Kaiser Wilhelm Koog Salzwiesen-Vorland	SH 33	Kaiser Wilhelm- und Neufelder Koog & Vorland
SH	**VD52**	Neufelder Koog, Salzwiesen-Vorland	SH 33	Kaiser Wilhelm- und Neufelder Koog & Vorland
Nds	**1.1.03.**01	Emsvorland Leer bis Emden: Außendeichsflächen Ditzum - Hatzum		
Nds	1.1.03.02	Emsvorland Leer bis Emden: Vorland Borßumer Siel - Oldersum		
Nds	1.1.03.03	Emsvorland Leer bis Emden: Midlumer Vorland		
Nds	1.1.03.08	Emsvorland Leer bis Emden: Oldersum bis Mittelsterborg		
Nds	1.1.03.09	Emsvorland Leer bis Emden: Sautelersiel bis Spittland		
Nds	**1.1.06.**02	Dollart Süd: Vorland Nord	Nds 10	Dollart
Nds	1.1.06.03	Dollart Süd: Vorland Süd	Nds 10	Dollart
Nds	1.1.06.04	Dollart Nord: Vorland	Nds 10	Dollart

Country	National site code	Name of counting unit	Spring tide counting site	Name of spring tide counting site
Nds	1.1.06.05	Dollart Nord: Pogum	Nds 10	Dollart
Nds	**1.1.07**.01	Rysumer Nacken: Vorland		
Nds	1.1.07.05	Rysumer Nacken: Süd		
Nds	**1.2.01**.01	Vorland Rysum bis Pilsum: Pilsum - Manslagter Vorland		
Nds	1.2.01.02	Vorland Rysum bis Pilsum: Manslagter Nacken Nord		
Nds	1.2.01.03	Vorland Rysum bis Pilsum: Manslagter Nacken Süd		
Nds	**1.2.02**.01	Leybucht Nord: Norddeich - Utlandshörn	Nds 11	Leybucht
Nds	1.2.02.02	Leybucht Süd: Leyhörn	Nds 11	Leybucht
Nds	1.2.02.03	Leybucht Süd: Hauener Hooge	Nds 11	Leybucht
Nds	1.2.02.04	Leybucht Nord: Buscher Heller	Nds 11	Leybucht
Nds	1.2.02.05	Leybucht Mitte: Mittelplate	Nds 11	Leybucht
Nds	1.2.02.06	Leybucht Mitte: Leybuchtpolder Heller	Nds 11	Leybucht
Nds	**1.2.03**.01	Borkum Nordwest		
Nds	1.2.03.02	Borkum Ostplate		
Nds	1.2.03.03	Borkum Süd: Binnendeichsflächen mit Tüskend-örsee		
Nds	1.2.03.04	Borkum Süd: Vorland Hopp		
Nds	1.2.03.05	Borkum Süd: Südstrand - Woldedünen		
Nds	**1.2.04**.01	Memmert: Sandplate	Nds 12	Memmert
Nds	1.2.04.02	Memmert: Dünen	Nds 12	Memmert
Nds	1.2.04.03	Lütje Hörn		
Nds	**1.2.05**.01	Juist West: Westheller mit Billriff		
Nds	1.2.05.02	Juist West: Hammersee		
Nds	1.2.05.03	Juist Ost: Ostheller		
Nds	1.2.05.04	Juist Ost: Kalfarmer		
Nds	1.2.05.05	Juist West: Billpolder		
Nds	1.2.05.06	Juist Ost: Oststrand		
Nds	**1.3.01**.01	Norderney West: Südstrandpolder		
Nds	1.3.01.02	Norderney West: Vorland		
Nds	1.3.01.03	Norderney West: Grohde Polder		
Nds	1.3.01.04	Norderney Ost: Ostheller - Ostbake		
Nds	1.3.01.05	Norderney Hafen: Hafenbucht		
Nds	1.3.01.06	Norderney West: Nordoststrand		
Nds	1.3.01.07	Norderney Hafen: Westkopf		
Nds	1.3.01.08	Norderney Nordwest: Meiereiwiesen		
Nds	1.3.01.09	Norderney Nordwest: Nordbad		
Nds	1.3.01.10	Norderney Ost: Nordstrand Mitte		
Nds	**1.3.02**.01	Baltrum: Baltrum Heller		
Nds	1.3.02.02	Baltrum: Westkopf		
Nds	1.3.02.03	Baltrum: Dünen und Strand		
Nds	**1.3.03**.01	Langeoog: Langeoog West		
Nds	1.3.03.02	Langeoog: Langeoog Süd		
Nds	1.3.03.03	Langeoog: Sommerpolder mit Ostheller		
Nds	1.3.03.04	Langeoog West: Binnenweiden		
Nds	1.3.03.05	Langeoog West: Ort		
Nds	1.3.03.06	Langeoog Ost: Vogelkolonie		
Nds	1.3.03.07	Langeoog Nord: Dünen und Schlopp		
Nds	**1.3.04**.01	Norddeich bis Neßmersiel: Hilgenriedersiel Vorland	Nds 13	Mittlere Ostfriesische Küste
Nds	1.3.04.02	Norddeich bis Neßmersiel: Hilgenriedersiel bis Neßmersiel Vorland	Nds 13	Mittlere Ostfriesische Küste
Nds	1.3.04.03	Norddeich bis Neßmersiel: Norddeich Ost Vorland	Nds 13	Mittlere Ostfriesische Küste
Nds	**1.3.05**.01	Norddeich bis Neßmersiel: Hilgenriedersiel Som-merpolder	Nds 13	Mittlere Ostfriesische Küste
Nds	1.3.05.04	Norddeich bis Neßmersiel: Hilgenriedersiel bis Neßmersiel Sommerpolder	Nds 13	Mittlere Ostfriesische Küste
Nds	**1.3.06**.01	Neßmersiel bis Dreihausen: Vorland	Nds 13	Mittlere Ostfriesische Küste

Country	National site code	Name of counting unit	Spring tide counting site	Name of spring tide counting site
Nds	1.3.06.02	Neßmersiel bis Dreihausen: Sommerpolder	Nds 13	Mittlere Ostfriesische Küste
Nds	1.3.06.03	Neßmersiel bis Dreihausen: Spülbecken	Nds 13	Mittlere Ostfriesische Küste
Nds	1.3.06.04	Dreihausen bis Dornumersiel: Vorland	Nds 13	Mittlere Ostfriesische Küste
Nds	1.3.06.05	Dreihausen bis Dornumersiel: Sommerpolder	Nds 13	Mittlere Ostfriesische Küste
Nds	**1.3.07**.01	Dornumersiel bis Bensersiel: Vorland	Nds 13	Mittlere Ostfriesische Küste
Nds	1.3.07.02	Bensersiel bis Neuharlingersiel: Vorland	Nds 13	Mittlere Ostfriesische Küste
Nds	**1.4.01**.01	Spiekeroog West	Nds 14	Spiekeroog
Nds	1.4.01.02	Spiekeroog Ost	Nds 14	Spiekeroog
Nds	1.4.01.03	Spiekeroog Nordweststrand	Nds 14	Spiekeroog
Nds	1.4.01.05	Spiekeroog Nordoststrand	Nds 14	Spiekeroog
Nds	**1.4.02**.01	Wangerooge West: Dünen und Strand	Nds 15	Wangerooge
Nds	1.4.02.02	Wangerooge Ost: Innengroden	Nds 15	Wangerooge
Nds	1.4.02.03	Wangerooge Ost: Vorland	Nds 15	Wangerooge
Nds	1.4.02.04	Wangerooge Ost: Dünen und Strand	Nds 15	Wangerooge
Nds	1.4.02.05	Wangerooge West: Innengroden	Nds 15	Wangerooge
Nds	1.4.02.06	Wangerooge West: Vorland	Nds 15	Wangerooge
Nds	**1.4.03**.01	Minsener Oog: Nordwatt		
Nds	1.4.03.02	Minsener Oog: Südwatt		
Nds	1.4.03.03	Minsener Oog: Insel		
Nds	**1.4.04**.01	Neuharlingersiel bis Carolinensiel: Neuharlingersiel Vorland		
Nds	1.4.04.02	Neuharlingersiel bis Carolinensiel: Neuharlingersiel Binnendeichsflächen		
Nds	1.4.04.03	Neuharlingersiel bis Carolinensiel: Harlesiel Vorland		
Nds	1.4.04.04	Neuharlingersiel bis Carolinensiel: Harlesiel Binnendeichsflächen		
Nds	**1.4.05**.01	Elisabethaußengroden West: Vorland	Nds 16	Elisabeth-Außengroden
Nds	1.4.05.02	Elisabethaußengroden Ost: Vorland West	Nds 16	Elisabeth-Außengroden
Nds	1.4.05.03	Elisabethaußengroden Ost: Vorland Ost	Nds 16	Elisabeth-Außengroden
Nds	**1.4.07**.01	Vorland Schillig bis Hooksiel: Vorland Nord		
Nds	1.4.07.02	Vorland Schillig bis Hooksiel: Vorland Süd		
Nds	**1.4.09**.01	Vorland Hooksiel bis Wilhelmshaven: Vorland		
Nds	1.4.09.02	Vorland Hooksiel bis Wilhelmshaven: Außenjade		
Nds	**1.5.01**.02	Vorland Jadebusen West: Vorland Nord	Nds 17	Jadebusen
Nds	1.5.01.03	Vorland Jadebusen: Eckwarderhörne - Iffens	Nds 17	Jadebusen
Nds	1.5.01.04	Vorland Jadebusen West: Vorland Süd	Nds 17	Jadebusen
Nds	1.5.01.05	Vorland Jadebusen Südwest: Vorland	Nds 17	Jadebusen
Nds	1.5.01.06	Vorland Jadebusen Ost: Vorland	Nds 17	Jadebusen
Nds	1.5.01.07	Vorland Jadebusen Süd	Nds 17	Jadebusen
Nds	1.5.01.08	Vorland Jadebusen Südost: Süderkleihörne	Nds 17	Jadebusen
Nds	1.5.01.09	Vorland Jadebusen Nord	Nds 17	Jadebusen
Nds	1.5.01.10	Vorland Jadebusen Südost: Vorland Diekmannshausen	Nds 17	Jadebusen
Nds	**1.5.02**.01	Binnendeichsflächen Jadebusen West		
Nds	**1.6.01**.01	Mellum: Mellum	Nds 18	Mellum
Nds	1.6.01.02	Mellum: Sandbank	Nds 18	Mellum
Nds	**1.6.02**.01	Vorland Butjadingen Langwarder Deich: Vorland		
Nds	1.6.02.02	Vorland Butjadingen Langwarder Deich: Langwarder und Fedderwarder-Groden		
Nds	1.6.02.03	Vorland Butjadingen: Tossens - Eckwarderhörne		
Nds	1.6.02.04	Vorland Butjadingen: Fedderwardersiel - Burhaversiel		
Nds	1.6.02.05	Vorland Butjadingen: Burhaversiel - Waddenserdeich		
Nds	1.6.02.06	Vorland Butjadingen: Tettenserhörne - Langlütjen		
Nds	1.6.02.07	Vorland Butjadingen: Langlütjen - Blexen		
Nds	1.6.02.08	Vorland Butjadingen: Waddenserdeich		
Nds	1.6.02.10	Vorland Butjadingen Ruhwarden / Tossens: Vorland		

Country	National site code	Name of counting unit	Spring tide counting site	Name of spring tide counting site
Nds	**1.7.01**.01	Knechtsand: Knechtsand		
Nds	1.7.01.02	Knechtsand: Eversand		
Nds	1.7.01.03	Knechtsand: Robbenplate		
Nds	**1.7.02**.01	Neuwerk: Innengroden		
Nds	1.7.02.02	Neuwerk: Zwischenzone		
Nds	1.7.02.03	Neuwerk: Ruhezone		
Nds	**1.7.03**.01	Scharhörn		
Nds	1.7.03.02	Nigehörn		
Nds	1.7.03.03	Scharhörn Sand		
Nds	**1.7.04**.01	Vorland Bremerhaven bis Cuxhaven: Kugelbake – Duhnen		
Nds	1.7.04.02	Vorland Bremerhaven bis Cuxhaven: Duhnen – Sahlenburg		
Nds	1.7.04.03	Vorland Bremerhaven bis Cuxhaven: Sahlenburg – Arensch Nord		
Nds	1.7.04.04	Vorland Bremerhaven bis Cuxhaven: Spieka Nord Vorland		
Nds	1.7.04.05	Vorland Bremerhaven bis Cuxhaven: Spieka Nord Sommerpolder		
Nds	1.7.04.06	Vorland Bremerhaven bis Cuxhaven: Spieka Süd Vorland		
Nds	1.7.04.07	Vorland Bremerhaven bis Cuxhaven: Spieka Süd Sommerpolder		
Nds	1.7.04.08	Vorland Bremerhaven bis Cuxhaven: Dorumer Neufeld Süd		
Nds	1.7.04.09	Vorland Bremerhaven bis Cuxhaven: Wremen Nord		
Nds	1.7.04.10	Vorland Bremerhaven bis Cuxhaven: Wremen Süd Vorland		
Nds	**1.8.01**.01	Vorland Cuxhaven bis Oste: Cuxhaven Stadt		
Nds	1.8.01.02	Vorland Cuxhaven bis Oste: Osterhöft - Altenbruch		
Nds	1.8.01.03	Vorland Cuxhaven bis Oste: Altenbruch - Wehldorf		
Nds	1.8.01.04	Vorland Cuxhaven bis Oste: Vorland		
Nds	1.8.01.05	Vorland Cuxhaven bis Oste: Hadeler Außendeich		
Nds	1.8.01.06	Vorland Cuxhaven bis Oste: Belumer Außendeich		
Nds	**1.8.03**.01	Vorland Oste bis Wischhafen: Nordkehdingen West	Nds 19	Hullen
Nds	1.8.03.02	Vorland Oste bis Wischhafen: Hullen	Nds 19	Hullen
Nds	1.8.03.03	Vorland Oste bis Wischhafen: Nordkehdingen Mitte	Nds 19	Hullen
Nds	1.8.03.04	Vorland Oste bis Wischhafen: Nordkehdingen Ost	Nds 19	Hullen
Nds	1.8.03.05	Vorland Oste bis Wischhafen: Allwördener Außen-deich / Brammersand	Nds 19	Hullen
Nds	**1.8.06**.02	Vorland Wischhafen bis Bützfletz: Krautsand Nord		
Nds	**1.9.01**.01	Bremerhaven Süd: Nordhafen - Neues Lunesiel		
Nds	1.9.01.02	Bremerhaven Süd: Vorland Luneplate		
Nds	1.9.01.04	Bremerhaven Süd: Großensiel - Beckumersiel		
Nds	**1.9.02**.01	Weser Strohauser Plate: Vorland		
Nds	1.9.02.03	Weser Strohauser Plate: Schweiburg Süd		
Nds	1.9.02.04	Weser Strohauser Plate: Strohauser Plate		
Nds	1.9.02.06	Weser Strohauser Plate: Tegelerplate		
Nds	1.9.02.08	Weser Strohauser Plate: Dedesdorf - Buttelersiel		
Nds	1.9.02.09	Weser Strohauser Plate: Buttelersiel - Sandstedt		
Nds	**1.9.03**.01	Weser Hammelwarder bis Harrier Sand: Rechter Nebenarm		
Nds	1.9.03.02	Weser Hammelwarder bis Harrier Sand: Harrier Sand Nord		
NL	**WG11**11	Polder Wassenaar - Zeeburg		
NL	WG1112	Waddenzee: vuurtoren - Zeeburg		
NL	WG1121	Polder de Eendracht		
NL	WG1122	De Schorren		
NL	WG1123	Waddenzee: De Schorren		

Country	National site code	Name of counting unit	Spring tide counting site	Name of spring tide counting site
NL	WG1131	Eijerland noord		
NL	WG1132	Eijerland zuid		
NL	WG1141	Polder het Noorden		
NL	WG1142	Oudeschild - Oosterend		
NL	WG1143	Waal en Burg		
NL	WG1144	Waddenzee: De Schorren - De Bol		
NL	WG1145	Waddenzee: De Bol - Oudeschild		
NL	WG1151	Hoornder Nieuwland		
NL	WG1152	De Westen / De Hemmer		
NL	WG1153	Den Burg - Oudeschild		
NL	WG1154	De Koog		
NL	WG1155	Haven Oudeschild		
NL	WG1161	Prins Hendrikpolder / Zuidhaffel		
NL	WG1162	Waddenzee: Oudeschild-'t Horntje		
NL	WG1163	Eendenkooi Westergeest		
NL	WG1171	Mok	NL 01	Mokbaai
NL	WG1172	De Hors		
NL	WG1181	Horsmeertjes + Geulplas		
NL	WG1182	Groote Vlak + De Geul		
NL	WG1183	Westerduinen		
NL	WG1184	Staatsbossen		
NL	WG1191	Korverskooi		
NL	WG1192	De Nederlanden		
NL	WG1193	De Muy		
NL	WG1194	De Slufter		
NL	WG1195	Eierlandsche Duinen		
NL	**WG12**11	Vliehors, west		
NL	WG1212	Vliehors, oost		
NL	WG1221	Kroon's polders		
NL	WG1222	Posthuiswad		
NL	WG1231	Glooiing		
NL	WG1232	Westerveld		
NL	WG1233	Wad bij Dorp		
NL	WG1241	Oostpunt		
NL	WG1242	Haven		
NL	WG1251	Meeuwenduinen		
NL	WG1252	Vallei van Oude Huizenlid		
NL	WG1253	Vallei van het Veen		
NL	WG1254	Kooisplek + Afloop		
NL	WG1255	Oost-Vlieland		
NL	**WG13**00	Richel		
NL	**WG14**10	Harlingen haven noord		
NL	WG1421	Harlingen haven zuid - Kimswerdenlaan, buitendijks		
NL	WG1422	Kimswerdenlaan - Zurich, buitendijks		
NL	WG1423	Polder Kimswerd west		
NL	WG1424	Polder de Eendracht west		
NL	WG1430	Zurich - Lorenzsluis		
NL	**WG15**11	Lorenzsluizen (Waddenzeezijde)		
NL	WG1512	Lorenzsluizen tot Breezand (Waddenzeezijde)		
NL	WG1513	Breezand (Waddenzeezijde)		
NL	WG1520	Waddenzee: Stevinsluizen tot Breezand		
NL	WG1530	Haven en Spuikom Den Oever		
NL	**WG16**31	Amsteldijk - Vatrop	NL 03	Wieringen
NL	WG1632	Normerven	NL 03	Wieringen
NL	WG1633	Vatrop	NL 03	Wieringen
NL	WG1634	Den Oever buitendijks	NL 03	Wieringen

Country	National site code	Name of counting unit	Spring tide counting site	Name of spring tide counting site
NL	WG1640	Wieringen binnendijks	NL 03	Wieringen
NL	**WG17**11	Balgzand telgebied 7: Marinehaven	NL 02	Balgzand
NL	WG1712	Balgzand telgebied 5: Kuitje	NL 02	Balgzand
NL	WG1721	Balgzand telgebied 3: Kooihoekschor	NL 02	Balgzand
NL	WG1722	Balgzand telgebied 2: Tussenschor	NL 02	Balgzand
NL	WG1731	Balgzand telgebied 1n: Van Ewijcksluisschor Nieuw	NL 02	Balgzand
NL	WG1732	Balgzand telgebied 1: Van Ewijcksluisschor	NL 02	Balgzand
NL	WG1740	Balgzand telgebied 4: Slikhoek (pl 11.5 - Amsteldi-epdijk, pl 15)	NL 02	Balgzand
NL	WG1750	Balgzandkanaal 6: Kanaaloever	NL 02	Balgzand
NL	**WG18**10	Huisduinen - Den Helder (Hp 1 t/m TESO veer)		
NL	WG1820	Marinehaven Den Helder		
NL	**WG21**11	Noordvaarder		
NL	WG2112	Kroonspolders + Groene Strand		
NL	WG2113	Haven		
NL	WG2121	Plaat of Dellewal		
NL	WG2122	Polder West		
NL	WG2123	Stryp		
NL	WG2130	Polder Noord		
NL	WG2141	Midsland - Formerum		
NL	WG2142	Formerum - Oosterend		
NL	WG2151	Oosterend - Wierschuur		
NL	WG2152	Grieen		
NL	WG2161	De Groede		
NL	WG2162	1e Duintjes		
NL	WG2163	2e Duintjes		
NL	WG2164	3e Duintjes		
NL	WG2165	4e Duintjes		
NL	WG2166	Punt en Muy		
NL	WG2167	Strandvlakte		
NL	WG2171	Doodemanskisten		
NL	WG2172	Duinplassen paal 8 - 13		
NL	WG2173	Weilandjes paal 15 - 19		
NL	**WG22**10	Ameland-west		
NL	WG2220	Ameland-oost		
NL	WG2222	Nieuwlandsreid	NL 05	Zoute Weide
NL	WG2223	Oerd en Hon	NL 06	Oerd
NL	**WG23**10	Plaat	NL 07	Engelsmanplaat
NL	WG2320	Rif	NL 07	Engelsmanplaat
NL	**WG24**00	Griend	NL 08	Griend
NL	**WG25**11	Sluizen - Hoek van de Bant		
NL	WG2512	Paesemerlannen		
NL	WG2521	Polder de Band		
NL	WG2522	Anjumer- en Lioessenserpolder		
NL	WG2530	Moddergat - Wierum buitendijks		
NL	WG2540	Moddergat - Wierum binnendijks		
NL	WG2550	Wierum - Ternaard buitendijks		
NL	WG2560	Wierum - Ternaard binnendijks		
NL	**WG26**11	Holwerd oost buitendijks	NL 09	Holwerd oost
NL	WG2612	Holwerd oost binnendijks	NL 09	Holwerd oost
NL	WG2621	Holwerd west buitendijks		
NL	WG2622	Holwerd west binnendijks		
NL	WG2631	Blija oost buitendijks		
NL	WG2632	Blija west buitendijks		
NL	WG2633	Blija oost binnendijks		
NL	WG2634	Blija west binnendijks		

Country	National site code	Name of counting unit	Spring tide counting site	Name of spring tide counting site
NL	WG2641	Ferwerd buitendijks		
NL	WG2642	Ferwerd binnendijks		
NL	WG2653	Noorderleeg west buitendijks noord		
NL	WG2654	Noorderleeg oost buitendijks noord		
NL	WG2655	Nijkerker polder		
NL	WG2656	Polder Vijfhuizen		
NL	WG2657	Noorderleegpolder binnendijks		
NL	WG2658	Polder Noorderleegs buitenveld		
NL	WG2659	Polder Bokkepollen en de Keegen		
NL	WG2662	Oude Bildtpollen west buitendijks		
NL	WG2663	Oude Bildtpollen oost binnendijks	NL 10	Oude Bildtpollen
NL	WG2664	Oude Bildtpollen west binnendijks		
NL	WG2665	Oude Bildtpollen oost buitendijks west	NL 10	Oude Bildtpollen
NL	WG2666	Oude Bildtpollen oost buitendijks oost	NL 10	Oude Bildtpollen
NL	**WG27**11	Koehool - Westhoek buitendijks		
NL	WG2712	Westhoek - Zwarte Haan buitendijks		
NL	WG2720	Polder de Koning		
NL	WG2730	Koehool - Voorgronden		
NL	WG2740	Koehool - Harlingen haven buitendijks		
NL	WG2750	Koehool - Harlingen haven binnendijks		
NL	**WG31**10	Rif		
NL	WG3121	Westerplas		
NL	WG3122	Banckspolder		
NL	WG3131	Nieuwe pier - 3e slenk (Oosterkwelder)		
NL	WG3132	3e slenk - 4e slenk		
NL	WG3133	Inlaag		
NL	WG3134	Balg		
NL	**WG32**10	Simonszand		
NL	WG3220	Simonsrif		
NL	**WG33**10	Rottumerplaat noord	NL 11	Rottumerplaat
NL	WG3320	Rottumerplaat zuid	NL 11	Rottumerplaat
NL	**WG34**10	Rottumeroog	NL 12	Rottumeroog
NL	WG3420	Zuiderduin	NL 12	Rottumeroog
NL	**WG35**11	Landaanwinningswerken Emmapolder		
NL	WG3512	Emmapolder, binnendijks		
NL	WG3513	Ruithorn, Plas Natuurmonumenten		
NL	WG3521	Lauwerpolder, kwelder		
NL	WG3522	Lauwerpolder, binnendijks		
NL	WG3531	Noordpolder west, kwelder	NL 13	Noordpolder
NL	WG3532	Noordpolder oost, kwelder		
NL	WG3533	Noordpolder west, binnendijks	NL 13	Noordpolder
NL	WG3534	Noordpolder oost, binnendijks		
NL	WG3536	Klutenplas, Groninger Landschap	NL 13	Noordpolder
NL	WG3541	Linthorst-Homanpolder kwelder		
NL	WG3542	Linthorst-Homanpolder binnendijks		
NL	WG3551	Negenboerenpolder kwelder		
NL	WG3552	Negenboerenpolder binnendijks		
NL	WG3553	Deikum		
NL	WG3561	Kwelder West en Julianapolder		
NL	WG3562	Julianapolder binnendijks		
NL	WG3563	Westpolder binnendijks		
NL	WG3571	Marnewaarddijk buitendijks		
NL	WG3572	Marnewaarddijk zoute kwel		
NL	WG3580	Haven Lauwersoog		
NL	**WG41**11	Eemshaven west		
NL	WG4112	Eemshaven haven		
NL	WG4113	Eemshaven oost		

Country	National site code	Name of counting unit	Spring tide counting site	Name of spring tide counting site
NL	WG4121	Eemshaven - Nansum kust		
NL	WG4122	N.A.M. locatie De Hond		
NL	WG4123	Hoogwatum		
NL	WG4131	Nansum - Delfzijl		
NL	WG4132	Holwierde		
NL	WG4141	Delfzijl - Oterdum, buitendijks		
NL	WG4142	Industrieterrein Delfzijl		
NL	WG4151	Oterdum - Punt van Reide, buitendijks		
NL	WG4152	Termunten		
NL	**WG42**10	Coupure JK/CC-polder - Punt van Reide	NL 14	Dollard
NL	WG4221	Coupure JK/CC-polder - betonnen brug	NL 14	Dollard
NL	WG4222	kwelder betonnen brug - Kamp CC-polder	NL 14	Dollard
NL	WG4223	kwelder Kamp CC-polder - Voormalige sluis	NL 14	Dollard
NL	WG4230	kwelder Nieuwe Statenzijl - Voormalige sluis	NL 14	Dollard
NL	WG4240	Johannes Kerkhovenpolder		
NL	WG4251	polder betonnen brug - Kamp CC-polder		
NL	WG4252	polder Kamp CC-polder - Voormalige sluis		
NL	WG4253	polder Nieuwe Statenzijl - Voormalige sluis		
NL	WG4260	Reiderwolderpolder-B		
NL	**WG52**00	Blauwe Balgplaat		
NL	**NZ31**31	Strand Texel: Paal 9 - 12		
NL	NZ3132	Strand Texel: Paal 12 - 15		
NL	NZ3133	Strand Texel: Paal 15 - 20		
NL	NZ3140	Strand Texel: Sluftermonding tot de Koog (paal 20 - 25)		
NL	NZ3150	Strand Texel: Vuurtoren tot Sluftermonding (paal 25 - 31)		
NL	**NZ32**10	Strand de Vliehors		
NL	NZ3220	Oostpunt tot Schietkamp		
NL	**NZ33**10	Strand: de Noordvaarder		
NL	NZ3320	Terschelling: paal 3 - paal 8		
NL	NZ3331	Terschelling: paal 8 - paal 14		
NL	NZ3332	Terschelling: paal 14 - paal 18		
NL	NZ3341	Terschelling: Paal 18 - paal 22		
NL	NZ3342	Terschelling: Paal 22 - paal 24		
NL	NZ3343	Terschelling: Paal 24 - paal 26		
NL	NZ3344	Terschelling: Paal 26 - paal 28		
NL	**NZ34**10	Ameland strand: Westpunt - Paal 13		
NL	NZ3420	Ameland strand: Paal 13 - Paal 19		
NL	NZ3430	Ameland strand: Paal 19 - Paal 25		
NL	**NZ35**20	Schier: Paal 2 (Westerstrand) - Paal 6.5 (Paviljoen de Grilk)		
NL	NZ3530	Schier: Paal 6.5 (Oosterstrand) - Paal 15		
NL	**NZ37**00	Noorderhaaks (Razende Bol)		

Annex 2

National totals and totals for the entire Wadden Sea for each synchronous counting date

(nine January counts, seven counts in other months)

The given numbers are the totals for each country, adding up the counted and estimated numbers per country and the entire Wadden Sea. Numbers are presented for all months; however, data scarcity in months with very low numbers violate conditions for trend analyses and thus for the calculation of estimates; those estimates should be interpreted very cautiously.

With regard to the numbers and results presented in the species accounts, some exceptions apply to the numbers in this table:

The numbers for cold winters are printed in italics.

The numbers for Common Shelduck (*) and Common Eider (**) are taken from ground counts only.

Numbers of Barnacle and Dark-bellied Brent Geese are calculated using a smaller counting interval of +/- 2 days.

Date	18.1.1992	9.1.1993	15.1.1994	21.1.1995	*20.1.1996*	*11.1.1997*	10.1.1998	16.1.1999	22.1.2000	14.3.1998	8.4.2000	6.5.1995	12.6.1999	17.8.1996	8.10.1994	15.11.1997
Great Cormorant																
DK counted	15	0	0	5	2	3	2	2	7	24	434	402	1,074	3,184	0	45
DK estimated	15	1	6	5	2	3	2	2	7	24	434	402	1,074	3,186	565	46
SH counted	0	7	6	23	9	1	25	16	33	21	387	123	1,290	2,863	819	46
SH estimated	5	8	17	27	10	2	31	19	35	63	449	156	1,408	3,174	895	61
NS counted	4	6	22	32	9	19	32	21	8	67	175	212	831	3,076	1,049	110
NS estimated	6	6	26	36	10	19	36	41	24	202	406	339	1,185	3,266	1,192	149
NL counted	2	20	48	374	49	1	242	939	300	262	1,345	702	5,194	8,218	1,758	468
NL estimated	127	23	322	382	50	6	306	939	306	262	1,348	702	5,194	8,253	2,998	468
Total counted	21	33	76	434	69	24	301	978	348	374	2,341	1,439	8,389	17,341	3,626	669
Total estimated	153	38	371	450	72	30	375	1,001	372	551	2,637	1,599	8,861	17,879	5,650	724
Eurasian Spoonbill																
DK counted	0	0	0	0	0	0	0	0	0	0	0	4	3	1	0	0
DK estimated	0	0	0	0	0	0	0	0	0	0	1	23	3	2	0	0
SH counted	0	0	0	0	0	0	0	0	0	0	0	4	3	1	0	0
SH estimated	0	0	0	0	0	0	0	0	0	0	1	23	3	2	0	0
NS counted	0	0	0	0	0	0	0	0	0	0	0	1	2	56	0	0
NS estimated	0	0	0	0	0	0	0	0	0	6	0	2	4	56	0	0
NL counted	0	0	0	0	0	0	0	0	0	89	265	131	515	1,264	4	0
NL estimated	0	0	0	0	0	0	0	0	0	89	278	131	515	1,264	10	0
Total counted	0	0	0	0	0	0	0	0	0	89	265	140	523	1,322	4	0
Total estimated	0	0	0	0	0	0	0	0	0	95	280	179	525	1,324	10	0
Barnacle Goose																
DK counted	1,500	0	0	0	0	7,189	20,085	18,081	1,522	30,934	34,596	205	2	0	0	17,513
DK estimated	5,330	8,808	30,255	18,747	481	8,400	21,473	18,096	13,804	30,952	34,596	205	2	0	602	17,513
SH counted	7,415	6,801	26,028	12,875	3,973	10,259	33,565	1,930	15,790	25,253	67,517	3,510	67	115	6,688	60,181
SH estimated	37,308	37,283	119,194	68,764	14,609	10,599	118,538	45,188	55,866	48,790	70,507	3,583	67	115	8,197	69,544
NS counted	11,705	10,660	23,775	43,200	5,916	655	34,351	24,424	13,153	25,471	35,003	3,638	19	117	4,246	17,874
NS estimated	13,587	12,500	31,419	44,270	6,404	1,979	40,778	33,938	22,922	35,286	69,539	3,856	19	117	4,282	26,154
NL counted	567	4,845	78,986	35,516	2,119	4	7,770	3,345	30,959	46,704	109,190	1,739	19	2	2,176	93,543
NL estimated	20,334	21,481	91,140	35,522	10,345	1,338	73,027	38,327	33,685	46,878	123,619	1,739	19	2	2,484	93,565
Total counted	21,187	22,306	128,789	91,591	12,008	18,107	95,771	47,780	61,424	128,362	246,306	9,092	107	234	13,110	189,111
Total estimated	76,559	80,072	272,008	167,303	31,839	22,316	253,816	135,549	126,277	161,906	298,261	9,383	107	234	15,565	206,776

Date	18.1.1992	9.1.1993	15.1.1994	21.1.1995	*20.1.1996*	*11.1.1997*	10.1.1998	16.1.1999	22.1.2000	14.3.1998	8.4.2000	6.5.1995	12.6.1999	17.8.1996	8.10.1994	15.11.1997
Dark-bellied Brent Goose																
DK counted	1,093	0	0	0	*9*	*2*	550	676	576	5,753	10,673	18,256	56	0	0	2,598
DK estimated	1,095	1,026	1,634	1,172	*167*	*127*	551	676	1,066	5,753	10,673	24,316	56	0	8,182	2,727
SH counted	716	1,262	3,747	874	*88*	*7*	694	448	805	40,126	81,348	95,510	155	41	30,308	3,160
SH estimated	1,378	1,474	3,895	1,359	*144*	*73*	816	556	881	45,271	98,650	98,501	169	53	35,124	5,739
NS counted	1,828	736	2,522	1,795	*776*	*233*	1,925	1,444	2,080	5,022	13,513	16,701	57	83	8,222	2,439
NS estimated	1,881	1,214	2,579	2,348	*977*	*405*	2,070	1,845	2,378	15,197	17,952	22,598	83	83	8,540	3,545
NL counted	0	14,904	31,639	33,047	*1*	*4,290*	0	0	22,862	67,122	79,201	105,430	139	44	17,692	42,792
NL estimated	26,751	30,072	45,779	33,725	*7,620*	*4,575*	21,350	19,488	24,383	71,386	81,939	106,098	139	45	21,383	42,879
Total counted	**3,637**	**16,902**	**37,908**	**35,716**	*874*	*4,532*	**3,169**	**2,568**	**26,323**	**118,023**	**184,735**	**235,897**	**407**	**168**	**56,222**	**50,989**
Total estimated	**31,105**	**33,786**	**53,887**	**38,604**	*8,908*	*5,180*	**24,787**	**22,565**	**28,708**	**137,607**	**209,214**	**251,513**	**447**	**181**	**73,229**	**54,890**
Common Shelduck*																
DK counted	26,000	0	0	20,240	*7,215*	*6,324*	11,837	14,780	19,355	3,917	2,818	1,980	9,583	946	0	21,534
DK estimated	27,453	16,042	32,539	21,803	*10,838*	*9,756*	11,839	14,782	25,460	3,917	2,818	1,980	9,583	946	21,740	21,924
SH counted	24,824	28,434	78,897	38,074	*18,448*	*24,386*	32,513	43,008	39,164	14,247	7,853	6,163	18,618	109,743	49,571	33,653
SH estimated	31,737	34,735	87,325	46,005	*21,096*	*24,973*	34,556	44,763	40,489	17,133	8,634	7,706	19,785	110,016	56,770	35,884
NS counted	24,411	19,794	22,980	33,738	*11,221*	*3,474*	14,730	19,268	20,660	5,018	8,798	6,024	4,022	7,399	60,460	33,605
NS estimated	34,249	22,011	36,788	35,304	*13,610*	*10,969*	24,629	37,717	38,571	19,387	12,621	6,593	9,304	7,863	63,095	45,392
NL counted	9,258	18,106	31,249	24,968	*12,700*	*2,978*	19,503	35,722	43,351	15,589	13,115	6,829	17,872	13,375	54,614	59,390
NL estimated	17,064	22,880	37,292	26,377	*13,569*	*5,167*	21,525	35,725	43,963	15,857	13,236	6,829	17,876	13,405	66,421	59,899
Total counted	**84,493**	**66,334**	**133,126**	**117,020**	*49,584*	*37,162*	**78,583**	**112,778**	**122,530**	**38,771**	**32,584**	**20,996**	**50,095**	**131,463**	**164,645**	**148,182**
Total estimated	**110,503**	**95,668**	**193,944**	**129,489**	*59,113*	*50,865*	**92,549**	**132,987**	**148,483**	**56,294**	**37,309**	**23,108**	**56,548**	**132,230**	**208,026**	**163,099**
Eurasian Wigeon																
DK counted	5,112	0	0	4,028	*1,168*	*4*	18,045	4,365	1,668	16,078	9,174	75	15	259	0	14,861
DK estimated	7,091	7,081	7,748	4,354	*2,226*	*548*	18,195	4,365	1,697	16,078	9,174	75	15	259	32,888	14,888
SH counted	71,345	74,243	85,670	81,462	*27,264*	*10,296*	89,902	33,426	60,526	51,323	14,789	369	540	363	130,911	77,160
SH estimated	86,825	95,320	104,506	92,720	*40,136*	*12,771*	99,303	36,837	62,916	59,807	20,185	534	541	840	155,323	87,865
NS counted	23,509	24,837	26,650	45,936	*32,674*	*3,328*	20,698	11,793	15,406	9,147	1,246	492	869	366	22,613	17,233
NS estimated	44,081	36,724	40,856	51,355	*45,072*	*10,167*	35,961	27,091	27,152	29,759	3,309	555	984	424	24,623	23,648
NL counted	82,302	63,680	95,735	75,990	*113,461*	*37,192*	79,983	70,703	52,018	26,855	3,430	46	13	168	51,588	52,169
NL estimated	98,379	93,231	101,446	79,783	*113,791*	*40,932*	89,766	70,730	52,362	28,313	3,526	46	13	168	58,122	52,711
Total counted	**182,268**	**162,760**	**208,055**	**207,416**	*174,567*	*50,820*	**208,628**	**120,287**	**129,618**	**103,403**	**28,639**	**982**	**1,437**	**1,156**	**205,112**	**161,423**
Total estimated	**236,376**	**232,356**	**254,556**	**228,212**	*201,225*	*64,418*	**243,225**	**139,023**	**144,127**	**133,957**	**36,194**	**1,210**	**1,553**	**1,691**	**270,956**	**179,112**

* The numbers for Common Shelduck in this table are taken from ground counts only; please refer to the species account for results of aerial counts of this species.

Date	18.1.1992	9.1.1993	15.1.1994	21.1.1995	*20.1.1996*	*11.1.1997*	10.1.1998	16.1.1999	22.1.2000	14.3.1998	8.4.2000	6.5.1995	12.6.1999	17.8.1996	8.10.1994	15.11.1997
Common Teal																
DK counted	275	0	0	131	*9*	*0*	97	102	45	998	2,434	58	367	365	0	809
DK estimated	291	46	81	136	*11*	*2*	97	102	62	998	2,434	58	367	365	1,939	812
SH counted	1,005	498	456	315	*30*	*8*	2,238	207	2,476	2,834	6,486	189	863	1,278	10,130	4,101
SH estimated	1,050	528	480	342	*36*	*9*	2,256	207	2,487	2,878	10,540	271	872	1,754	10,850	6,209
NS counted	2,057	658	1,394	773	*496*	*23*	207	184	561	526	1,117	120	216	717	2,914	1,652
NS estimated	2,871	917	1,633	2,030	*593*	*81*	1,118	1,699	4,639	1,034	3,973	195	281	1,089	4,548	2,918
NL counted	1,463	546	1,414	2,434	*491*	*38*	700	2,753	4,356	2,092	3,943	59	218	662	2,493	5,988
NL estimated	1,735	735	1,668	2,518	*498*	*51*	973	2,753	4,396	2,092	3,952	59	218	662	2,691	6,016
Total counted	**4,800**	**1,702**	**3,264**	**3,653**	*1,026*	*69*	**3,242**	**3,246**	**7,438**	**6,450**	**13,980**	**426**	**1,664**	**3,022**	**15,537**	**12,550**
Total estimated	**5,947**	**2,226**	**3,862**	**5,026**	*1,138*	*143*	**4,444**	**4,761**	**11,584**	**7,002**	**20,899**	**583**	**1,738**	**3,870**	**20,028**	**15,955**
Mallard																
DK counted	14,525	0	0	17,942	*2,048*	*1,237*	6,142	9,823	8,430	5,156	1,689	301	593	1,381	0	6,564
DK estimated	15,428	10,720	14,595	18,526	*2,934*	*2,639*	6,860	9,823	9,021	5,156	1,689	301	593	1,381	3,983	6,602
SH counted	57,771	34,970	40,346	35,765	*11,381*	*10,410*	27,925	19,094	36,228	9,837	3,113	2,504	9,070	10,725	19,946	16,709
SH estimated	72,572	49,057	53,792	45,799	*15,773*	*12,151*	32,996	23,746	39,732	11,782	3,454	3,364	10,031	14,538	25,235	17,477
NS counted	23,660	32,621	39,409	45,831	*9,352*	*7,260*	22,399	18,398	21,647	3,432	2,050	2,153	4,592	7,170	24,570	16,931
NS estimated	34,290	38,919	50,316	50,144	*13,928*	*12,783*	30,667	37,518	35,490	15,402	3,745	2,802	8,423	9,435	28,762	22,573
NL counted	14,709	20,748	53,345	51,606	*26,399*	*11,776*	30,998	60,002	44,701	7,506	6,456	2,070	7,840	15,062	30,909	24,037
NL estimated	42,372	32,423	59,613	53,025	*29,081*	*13,739*	32,605	60,008	45,224	7,506	6,462	2,073	7,841	15,062	39,236	24,075
Total counted	**110,665**	**88,339**	**133,100**	**151,144**	*49,180*	*30,683*	**87,464**	**107,317**	**111,006**	**25,931**	**13,308**	**7,028**	**22,095**	**34,338**	**75,425**	**64,241**
Total estimated	**164,662**	**131,119**	**178,316**	**167,494**	*61,716*	*41,312*	**103,128**	**131,095**	**129,467**	**39,846**	**15,350**	**8,540**	**26,888**	**40,416**	**97,216**	**70,727**
Northern Pintail																
DK counted	2,683	0	0	2,071	*336*	*4*	222	1,909	1,329	4,746	1,277	12	9	80	0	2,796
DK estimated	4,338	1,513	2,057	3,916	*859*	*97*	222	1,909	3,154	4,746	1,277	12	9	80	2,105	2,796
SH counted	1,608	261	649	910	*22*	*5*	749	550	1,632	4,298	3,383	130	84	49	4,009	1,728
SH estimated	1,670	418	801	1,183	*84*	*15*	825	685	1,865	4,510	3,875	157	94	55	4,540	1,952
NS counted	1,402	698	745	1,901	*132*	*23*	414	682	596	691	366	35	63	43	2,044	770
NS estimated	1,654	729	848	1,975	*185*	*44*	517	888	1,205	2,999	1,350	42	75	43	2,229	1,066
NL counted	4,206	2,357	3,841	6,589	*2,213*	*17*	2,178	3,885	6,280	2,547	1,779	56	8	32	5,055	4,584
NL estimated	5,125	3,070	4,077	6,843	*2,218*	*89*	2,613	3,885	6,328	2,547	1,780	56	8	32	6,260	4,599
Total counted	**9,899**	**3,316**	**5,235**	**11,471**	*2,703*	*49*	**3,563**	**7,026**	**9,837**	**12,282**	**6,805**	**233**	**164**	**204**	**11,108**	**9,878**
Total estimated	**12,787**	**5,730**	**7,783**	**13,917**	*3,346*	*245*	**4,177**	**7,367**	**12,552**	**14,802**	**8,282**	**267**	**186**	**210**	**15,134**	**10,413**

Date	18.1.1992	9.1.1993	15.1.1994	21.1.1995	*20.1.1996*	*11.1.1997*	10.1.1998	16.1.1999	22.1.2000	14.3.1998	8.4.2000	6.5.1995	12.6.1999	17.8.1996	8.10.1994	15.11.1997
Northern Shoveler																
DK counted	9	0	0	0	*2*	*0*	0	0	0	4	157	29	141	128	0	18
DK estimated	9	2	3	0	*2*	*0*	0	0	3	4	157	29	141	128	40	18
SH counted	801	111	382	212	*2*	*9*	20	0	313	41	1,238	180	910	1,207	2,944	2,301
SH estimated	850	121	396	220	*8*	*9*	22	6	330	46	1,630	270	921	1,482	2,971	2,326
NS counted	114	75	8	18	*41*	*15*	0	60	37	58	138	107	136	829	379	348
NS estimated	119	77	13	21	*42*	*16*	2	75	70	164	680	121	206	1,151	524	428
NL counted	432	168	266	165	*25*	*15*	69	270	520	140	710	154	254	409	665	758
NL estimated	776	252	419	171	*25*	*33*	100	271	523	140	714	155	254	409	1,193	758
Total counted	**1,356**	**354**	**656**	**395**	*70*	*39*	**89**	**330**	**870**	**243**	**2,243**	**470**	**1,441**	**2,573**	**3,988**	**3,425**
Total estimated	**1,754**	**452**	**831**	**412**	*77*	*58*	**124**	**352**	**926**	**354**	**3,181**	**575**	**1,522**	**3,170**	**4,728**	**3,530**
Common Eider**																
DK counted	41,907	0	0	60,718	*16,063*	*441*	18,154	20,940	21,865	19,150	5,958	4,937	1,648	6,914	0	29,449
DK estimated	43,179	11,264	8,987	61,825	*27,813*	*13,131*	19,195	21,546	26,524	19,150	5,958	4,937	1,648	7,581	17,450	30,732
SH counted	21,010	10,692	6,860	27,343	*2,686*	*14,117*	53,656	5,053	20,427	14,766	11,758	6,190	17,300	25,574	64,303	23,460
SH estimated	30,946	15,688	11,209	32,999	*20,173*	*16,903*	58,133	8,812	31,780	18,261	12,661	9,360	24,388	28,394	68,410	43,556
NS counted	20,166	10,707	9,059	17,992	*4,467*	*9,658*	24,879	3,643	33,557	3,563	13,049	8,545	6,902	11,306	11,520	8,343
NS estimated	39,320	11,693	13,365	32,413	*30,171*	*23,377*	40,213	18,320	55,579	12,931	13,457	9,151	10,581	12,838	13,371	12,175
NL counted	22,434	11,127	8,806	17,092	*109,871*	*35,937*	10,315	58,301	65,813	34,691	42,582	53,791	41,527	49,059	19,695	16,170
NL estimated	54,562	17,092	12,201	19,872	*112,230*	*39,251*	31,180	58,910	72,048	35,978	45,126	53,791	41,527	49,334	24,622	17,715
Total counted	**105,517**	**32,526**	**24,725**	**123,145**	*133,087*	*60,153*	**107,004**	**87,937**	**141,662**	**72,170**	**73,347**	**73,463**	**67,377**	**92,853**	**95,518**	**77,422**
Total estimated	**168,007**	**55,737**	**45,762**	**147,109**	*190,387*	*92,662*	**148,721**	**107,588**	**185,931**	**86,320**	**77,202**	**77,239**	**78,144**	**98,147**	**123,853**	**104,178**
Eurasian Oystercatcher																
DK counted	18,734	0	0	34,421	*16,333*	*7,683*	33,511	27,856	36,810	43,219	25,388	11,845	4,144	40,015	0	29,445
DK estimated	19,138	33,749	31,598	34,837	*21,791*	*12,397*	33,591	27,901	43,629	43,219	25,388	11,845	4,144	40,015	22,875	32,682
SH counted	98,463	74,447	102,394	101,736	*59,113*	*41,768*	109,772	81,102	99,117	77,342	62,187	45,470	30,967	94,802	130,834	106,301
SH estimated	112,394	134,593	145,872	136,241	*101,901*	*54,955*	138,505	105,415	118,077	92,942	67,892	52,461	34,227	104,643	155,117	115,416
NS counted	137,305	145,188	127,284	154,316	*138,240*	*40,809*	97,256	83,712	79,373	51,292	57,231	45,884	22,284	94,514	135,684	77,521
NS estimated	168,199	173,425	141,375	169,384	*178,110*	*69,634*	123,111	122,066	106,070	151,689	69,442	48,692	29,289	97,340	153,775	108,366
NL counted	171,234	137,561	189,770	220,887	*248,056*	*66,361*	174,365	200,544	168,572	97,777	74,190	41,504	34,243	185,716	191,614	174,267
NL estimated	232,299	237,401	226,421	257,402	*266,878*	*100,002*	205,308	200,714	175,614	98,862	75,736	41,504	34,243	188,036	241,280	178,000
Total counted	**425,736**	**357,196**	**419,448**	**511,360**	*461,742*	*156,621*	**414,904**	**393,214**	**383,872**	**269,630**	**218,996**	**144,703**	**91,638**	**415,047**	**458,132**	**387,534**
Total estimated	**532,030**	**579,168**	**545,266**	**597,864**	*568,680*	*236,988*	**500,515**	**456,096**	**443,390**	**386,712**	**238,458**	**154,502**	**101,903**	**430,034**	**573,047**	**434,464**

** The numbers for Common Eider in this table are taken from ground counts only; please refer to the species account for results of aerial counts of this species.

Date	18.1.1992	9.1.1993	15.1.1994	21.1.1995	*20.1.1996*	*11.1.1997*	10.1.1998	16.1.1999	22.1.2000	14.3.1998	8.4.2000	6.5.1995	12.6.1999	17.8.1996	8.10.1994	15.11.1997
Pied Avocet																
DK counted	0	0	0	0	0	0	0	0	0	87	1,337	1,499	1,088	4,813	0	111
DK estimated	0	0	0	0	0	0	0	0	0	87	1,337	1,499	1,088	4,813	577	111
SH counted	0	0	0	0	0	0	0	0	4	537	6,929	4,717	5,618	5,521	1,075	288
SH estimated	0	0	0	0	0	0	0	0	4	678	7,419	6,746	6,156	5,802	1,885	328
NS counted	48	5	1	131	15	0	2	0	36	36	1,386	1,465	619	7,095	30,392	6,255
NS estimated	67	5	7	131	16	0	2	5	106	1,059	3,911	1,792	1,265	7,504	31,425	8,218
NL counted	508	6	235	264	34	0	2	156	774	2,770	8,237	4,536	4,821	6,575	14,920	13,211
NL estimated	1,079	10	392	264	34	4	3	156	774	2,770	8,245	4,536	4,821	6,598	18,331	13,232
Total counted	**556**	**11**	**236**	**395**	49	0	**4**	**156**	**814**	**3,430**	**17,889**	**12,217**	**12,146**	**24,004**	**46,387**	**19,865**
Total estimated	**1,146**	**15**	**399**	**395**	50	4	**5**	**161**	**884**	**4,594**	**20,912**	**14,573**	**13,330**	**24,717**	**52,218**	**21,889**
Great Ringed Plover																
DK counted	0	0	0	0	0	0	0	0	0	212	182	151	174	1,436	0	1
DK estimated	0	0	0	0	0	0	0	0	0	212	182	151	174	1,436	0	1
SH counted	6	16	0	60	0	0	4	13	2	460	455	3,491	472	13,447	600	31
SH estimated	6	28	25	66	1	0	6	30	10	521	565	4,686	504	14,435	924	32
NS counted	0	0	0	22	0	0	0	0	0	750	203	663	261	5,858	1,736	19
NS estimated	0	0	0	22	0	0	0	0	7	1,392	362	795	335	6,109	2,175	33
NL counted	62	12	59	31	8	0	2	48	143	389	320	492	694	6,592	388	86
NL estimated	73	29	87	33	8	3	5	48	145	389	332	492	694	6,592	705	86
Total counted	**68**	**28**	**59**	**113**	8	0	**6**	**61**	**145**	**1,811**	**1,160**	**4,797**	**1,601**	**27,333**	**2,724**	**137**
Total estimated	**79**	**57**	**112**	**121**	9	3	**11**	**78**	**162**	**2,514**	**1,441**	**6,124**	**1,707**	**28,572**	**3,804**	**152**
Kentish Plover																
DK counted	0	0	0	0	0	0	0	0	0	0	20	0	52	16	0	0
DK estimated	0	0	0	0	0	0	0	0	0	0	20	0	52	16	0	0
SH counted	0	0	0	0	0	0	0	0	0	0	81	96	140	391	7	0
SH estimated	0	0	0	0	0	0	0	0	0	674	81	115	140	404	15	0
NS counted	0	0	0	0	0	0	0	0	0	0	6	38	46	113	211	0
NS estimated	0	0	0	0	0	0	0	0	0	12	12	42	50	113	295	0
NL counted	0	0	0	0	0	0	0	0	0	1	26	16	30	57	2	0
NL estimated	0	0	0	0	0	0	0	0	0	1	26	16	30	57	2	0
Total counted	**0**	**0**	**0**	**0**	0	0	**0**	**0**	**0**	**1**	**133**	**150**	**268**	**577**	**220**	**0**
Total estimated	**0**	**0**	**0**	**0**	0	0	**0**	**0**	**0**	**687**	**139**	**173**	**272**	**590**	**312**	**0**

Date	18.1.1992	9.1.1993	15.1.1994	21.1.1995	*20.1.1996*	*11.1.1997*	10.1.1998	16.1.1999	22.1.2000	14.3.1998	8.4.2000	6.5.1995	12.6.1999	17.8.1996	8.10.1994	15.11.1997
Eurasian Golden Plover																
DK counted	14,115	0	0	1,508	*72*	*2*	4,466	583	5,282	30,651	16,214	6,928	33	13,682	0	51,017
DK estimated	14,816	1,349	2,961	1,532	*126*	*53*	4,467	625	5,715	30,651	16,214	6,928	33	13,682	6,208	51,024
SH counted	1,884	1,178	340	2,540	*2*	*0*	1,708	37	614	24,103	20,749	8,732	44	21,914	8,516	26,087
SH estimated	3,147	1,396	799	2,724	*40*	*3*	1,828	108	872	48,983	33,497	9,366	49	27,053	9,806	34,768
NS counted	623	623	559	1,132	*34*	*0*	338	56	646	12,415	3,608	2,391	1	14,951	10,493	8,402
NS estimated	1,175	665	617	1,152	*39*	*3*	611	134	824	44,132	8,869	2,931	6	21,106	11,067	17,501
NL counted	11,281	980	6,281	3,847	*2,209*	*1*	12,313	8,749	15,912	51,560	39,774	2,706	21	18,149	13,176	44,407
NL estimated	15,894	1,958	6,966	4,158	*2,262*	*37*	14,326	8,750	16,196	51,560	39,774	2,706	21	18,198	14,947	44,422
Total counted	**27,903**	**2,781**	**7,180**	**9,027**	*2,317*	*3*	**18,825**	**9,425**	**22,454**	**118,729**	**80,345**	**20,757**	**99**	**68,696**	**32,185**	**129,913**
Total estimated	**35,032**	**5,368**	**11,343**	**9,566**	*2,467*	*96*	**21,232**	**9,617**	**23,607**	**175,326**	**98,354**	**21,931**	**109**	**80,039**	**42,028**	**147,715**
Grey Plover																
DK counted	163	0	0	660	*218*	*51*	490	598	436	813	1,170	4,673	391	4,937	0	1,937
DK estimated	178	458	577	661	*227*	*55*	490	598	455	813	1,170	4,673	391	4,937	1,646	1,953
SH counted	6,307	1,344	3,297	5,625	*1,374*	*434*	4,665	2,843	5,182	6,421	15,396	25,666	2,078	29,315	22,786	10,222
SH estimated	7,158	6,449	9,493	13,103	*3,822*	*869*	7,037	5,771	9,852	8,328	15,532	32,152	2,289	31,228	25,087	10,692
NS counted	7,133	2,533	6,618	16,589	*3,319*	*1,178*	771	2,055	7,281	1,819	12,709	30,191	447	19,008	29,006	7,050
NS estimated	10,038	3,963	7,536	17,846	*4,286*	*1,417*	1,519	3,000	8,175	11,988	13,346	45,889	872	20,179	31,045	11,389
NL counted	9,331	13,259	17,133	17,433	*8,041*	*502*	8,658	11,936	17,619	10,905	12,939	31,492	1,308	32,018	19,343	17,536
NL estimated	12,254	19,517	20,528	21,275	*8,273*	*866*	9,506	11,943	17,854	10,905	13,318	31,492	1,308	32,272	34,589	17,607
Total counted	**22,934**	**17,136**	**27,048**	**40,307**	*12,952*	*2,165*	**14,584**	**17,432**	**30,518**	**19,958**	**42,214**	**92,022**	**4,224**	**85,278**	**71,135**	**36,745**
Total estimated	**29,628**	**30,387**	**38,134**	**52,885**	*16,608*	*3,207*	**18,552**	**21,312**	**36,336**	**32,034**	**43,366**	**114,206**	**4,860**	**88,616**	**92,367**	**41,641**
Northern Lapwing																
DK counted	0	0	0	19	*12*	*0*	1,047	1	247	13,421	721	630	1,482	5,761	0	15,254
DK estimated	350	45	97	29	*17*	*5*	1,048	34	249	13,421	721	630	1,482	5,761	663	15,254
SH counted	309	0	26	229	*2*	*2*	922	6	376	5,928	2,705	2,018	6,897	10,119	4,605	26,216
SH estimated	490	21	55	242	*8*	*4*	951	61	498	8,652	3,463	2,703	7,068	14,553	6,179	34,181
NS counted	299	76	350	323	*9*	*0*	393	187	197	3,531	913	1,469	1,222	17,604	4,888	8,373
NS estimated	525	113	354	389	*34*	*7*	719	453	1,067	14,398	2,917	1,723	2,694	24,239	6,219	13,347
NL counted	4,130	383	894	389	*658*	*0*	991	3,732	7,185	8,031	2,750	1,684	2,452	6,276	8,547	27,341
NL estimated	4,600	521	974	411	*667*	*25*	1,532	3,754	7,443	8,031	2,750	1,688	2,452	6,276	12,381	27,429
Total counted	**4,738**	**459**	**1,270**	**960**	*681*	*2*	**3,353**	**3,926**	**8,005**	**30,911**	**7,089**	**5,801**	**12,053**	**39,760**	**18,040**	**77,184**
Total estimated	**5,965**	**700**	**1,480**	**1,071**	*726*	*41*	**4,250**	**4,302**	**9,257**	**44,502**	**9,851**	**6,744**	**13,696**	**50,829**	**25,442**	**90,211**

Date	18.1.1992	9.1.1993	15.1.1994	21.1.1995	*20.1.1996*	*11.1.1997*	10.1.1998	16.1.1999	22.1.2000	14.3.1998	8.4.2000	6.5.1995	12.6.1999	17.8.1996	8.10.1994	15.11.1997
Red Knot																
DK counted	0	0	0	4,723	*2,411*	*50*	1,475	6,414	13,838	3,472	19,190	19,905	3,291	5,429	0	2,354
DK estimated	0	1,230	3,623	4,723	*2,411*	*51*	1,475	6,414	14,340	3,472	19,190	19,905	3,291	5,429	4,034	2,476
SH counted	8,419	1,422	4,718	23,710	*8,377*	*1,089*	5,498	3,790	12,530	61,725	118,525	170,327	24,016	104,405	60,990	2,223
SH estimated	12,824	3,411	10,810	30,161	*10,438*	*1,314*	10,644	9,705	13,580	80,177	128,468	202,014	24,154	108,490	101,413	2,352
NS counted	2,326	36	230	156	*4*	*0*	3,000	1,711	410	1	304	9,762	3,523	18,941	1,167	0
NS estimated	2,326	203	230	156	*398*	*29*	3,000	1,902	410	2,682	315	13,341	4,225	19,492	90,998	472
NL counted	59,890	12,376	72,443	74,935	*28,758*	*288*	69,812	119,555	113,937	44,553	34,756	28,868	1,735	50,414	38,092	90,081
NL estimated	83,348	25,275	73,706	106,590	*28,931*	*3,465*	131,290	119,555	114,673	44,553	34,756	28,868	1,735	50,520	43,268	90,081
Total counted	**70,635**	**13,834**	**77,391**	**103,524**	*39,550*	*1,427*	**79,785**	**131,470**	**140,715**	**109,751**	**172,775**	**228,862**	**32,565**	**179,189**	**100,249**	**94,658**
Total estimated	**98,498**	**30,119**	**88,369**	**141,630**	*42,178*	*4,859*	**146,409**	**137,576**	**143,003**	**130,884**	**182,729**	**264,128**	**33,405**	**183,931**	**239,713**	**95,381**
Sanderling																
DK counted	456	0	0	380	*1*	*88*	1,235	1,126	931	748	705	787	117	395	0	78
DK estimated	871	851	1,100	825	*522*	*686*	1,754	1,567	931	748	705	787	117	395	218	78
SH counted	561	40	72	121	*29*	*46*	20	156	311	1,633	1,524	3,443	565	1,514	4,390	201
SH estimated	593	474	627	553	*549*	*584*	508	565	807	1,934	1,569	3,999	601	1,627	5,130	246
NS counted	322	443	1,819	1,546	*764*	*702*	426	179	997	19	437	459	126	942	2,654	444
NS estimated	903	1,008	1,820	1,561	*1,185*	*936*	727	251	1,004	2,272	465	693	146	955	3,285	529
NL counted	1,502	1,158	1,362	2,069	*3,992*	*3,699*	3,045	3,378	3,659	2,547	3,676	2,317	460	4,112	702	2,852
NL estimated	3,036	2,933	3,145	2,819	*4,133*	*4,739*	3,763	3,383	4,006	2,547	3,676	2,317	460	4,399	3,320	2,996
Total counted	**2,841**	**1,641**	**3,253**	**4,116**	*4,786*	*4,535*	**4,726**	**4,839**	**5,898**	**4,947**	**6,342**	**7,006**	**1,268**	**6,963**	**7,746**	**3,575**
Total estimated	**5,403**	**5,266**	**6,692**	**5,758**	*6,389*	*6,945*	**6,752**	**5,766**	**6,748**	**7,501**	**6,415**	**7,796**	**1,324**	**7,376**	**11,953**	**3,849**
Curlew Sandpiper																
DK counted	0	0	0	0	*0*	*0*	0	0	0	0	0	0	0	44	0	0
DK estimated	0	0	0	0	*0*	*0*	0	0	0	0	0	0	0	44	0	0
SH counted	0	0	0	0	*0*	*0*	0	0	0	0	2	16	41	10,032	34	0
SH estimated	0	0	0	0	*0*	*0*	0	0	0	0	3	77	44	10,118	113	0
NS counted	0	0	0	0	*0*	*0*	0	0	0	0	0	5	0	130	7	0
NS estimated	0	0	0	0	*0*	*0*	0	0	0	2	0	6	0	201	13	0
NL counted	0	0	0	0	*0*	*0*	0	0	0	0	1	15	3	956	10	1
NL estimated	0	0	0	0	*0*	*0*	0	0	0	0	1	15	3	956	255	1
Total counted	**0**	**0**	**0**	**0**	*0*	*0*	**0**	**0**	**0**	**0**	**3**	**36**	**44**	**11,162**	**51**	**1**
Total estimated	**0**	**0**	**0**	**0**	*0*	*0*	**0**	**0**	**0**	**2**	**4**	**98**	**47**	**11,319**	**381**	**1**

Date	18.1.1992	9.1.1993	15.1.1994	21.1.1995	*20.1.1996*	*11.1.1997*	10.1.1998	16.1.1999	22.1.2000	14.3.1998	8.4.2000	6.5.1995	12.6.1999	17.8.1996	8.10.1994	15.11.1997
Dunlin																
DK counted	49,115	0	0	25,066	*14,446*	*1,070*	46,607	25,198	31,946	164,496	153,901	248,474	668	297,478	0	45,509
DK estimated	49,659	15,474	29,781	25,100	*20,545*	*2,755*	46,610	25,200	45,070	164,496	153,901	248,474	668	297,478	163,850	52,078
SH counted	65,056	11,867	12,715	42,200	*15,197*	*10,775*	37,011	27,215	55,364	165,306	279,777	305,258	885	393,386	296,363	150,684
SH estimated	72,475	21,976	30,404	58,980	*24,735*	*12,500*	50,360	37,865	72,121	215,968	291,583	374,229	1,354	409,705	421,736	160,153
NS counted	33,659	21,002	24,453	35,757	*10,059*	*2,460*	5,293	14,558	27,633	51,555	116,695	147,272	6,840	116,989	165,951	45,902
NS estimated	51,118	23,864	34,823	48,939	*24,430*	*5,462*	24,753	31,355	48,265	171,626	156,297	182,600	7,732	126,524	207,370	68,507
NL counted	69,943	16,924	97,069	108,840	*69,977*	*2,186*	93,480	85,335	176,711	248,896	302,561	198,425	651	183,340	200,836	219,754
NL estimated	100,075	46,149	111,290	127,215	*73,367*	*8,564*	136,104	85,341	182,920	248,896	313,037	198,425	651	187,141	294,736	219,881
Total counted	**217,773**	**49,793**	**134,237**	**211,863**	*109,679*	*16,491*	**182,391**	**152,306**	**291,654**	**630,253**	**852,934**	**899,429**	**9,044**	**991,193**	**663,150**	**461,849**
Total estimated	**273,327**	**107,463**	**206,298**	**260,234**	*143,077*	*29,281*	**257,827**	**179,761**	**348,376**	**800,986**	**914,818**	**1,003,728**	**10,405**	**1,020,848**	**1,087,692**	**500,619**
Ruff																
DK counted	0	0	0	0	*0*	*0*	1	0	0	1	11	1,765	11	455	0	4
DK estimated	1	0	1	0	*0*	*0*	1	0	0	1	11	1,765	11	455	0	4
SH counted	0	0	0	0	*0*	*0*	0	0	0	1	122	1,678	201	3,887	23	0
SH estimated	0	0	0	0	*0*	*0*	0	0	0	1	191	3,912	201	5,575	23	0
NS counted	0	0	0	0	*0*	*0*	0	0	0	0	14	206	53	187	0	0
NS estimated	0	0	0	0	*0*	*0*	0	0	0	0	91	342	83	279	0	0
NL counted	173	51	347	61	*129*	*0*	8	0	108	14	92	98	12	195	20	20
NL estimated	178	53	356	61	*129*	*0*	8	0	108	14	92	98	12	195	20	20
Total counted	**173**	**51**	**347**	**61**	*129*	*0*	**9**	**0**	**108**	**16**	**239**	**3,747**	**277**	**4,724**	**43**	**24**
Total estimated	**179**	**53**	**357**	**61**	*129*	*0*	**9**	**0**	**108**	**16**	**385**	**6,117**	**307**	**6,504**	**43**	**24**
Bar-tailed Godwit																
DK counted	2,450	0	0	3,874	*15*	*0*	1,404	2,137	565	3,868	19,560	64,782	652	14,814	0	2,268
DK estimated	2,450	860	1,381	3,874	*377*	*40*	1,404	2,137	2,007	3,868	19,560	64,782	652	14,814	12,927	2,614
SH counted	8,402	5,915	7,642	9,139	*11,903*	*794*	2,568	1,962	3,613	21,613	24,747	108,588	4,951	35,829	21,844	11,714
SH estimated	14,407	7,713	9,796	10,460	*12,140*	*905*	2,611	2,061	6,534	22,415	27,206	121,047	5,233	39,478	31,744	11,782
NS counted	902	5	341	1,189	*123*	*0*	151	680	1,375	1	5,442	40,618	2,308	19,124	11,996	518
NS estimated	1,281	76	341	1,189	*326*	*7*	151	685	1,375	2,336	5,511	46,271	3,180	20,007	16,426	1,651
NL counted	27,800	5,059	14,565	17,767	*9,724*	*206*	13,249	20,501	64,227	30,055	34,437	134,030	4,781	59,963	30,558	37,474
NL estimated	35,606	8,006	14,912	22,855	*9,901*	*659*	16,210	20,502	64,547	30,055	35,215	134,030	4,781	62,178	32,875	37,474
Total counted	**39,554**	**10,979**	**22,548**	**31,969**	*21,765*	*1,000*	**17,372**	**25,280**	**69,780**	**55,537**	**84,186**	**348,018**	**12,692**	**129,730**	**64,398**	**51,974**
Total estimated	**53,744**	**16,655**	**26,430**	**38,378**	*22,744*	*1,611*	**20,376**	**25,385**	**74,463**	**58,674**	**87,492**	**366,130**	**13,846**	**136,477**	**93,972**	**53,521**

Date	18.1.1992	9.1.1993	15.1.1994	21.1.1995	20.1.1996	11.1.1997	10.1.1998	16.1.1999	22.1.2000	14.3.1998	8.4.2000	6.5.1995	12.6.1999	17.8.1996	8.10.1994	15.11.1997
Whimbrel																
DK counted	0	0	0	0	0	0	0	0	0	0	0	149	9	238	0	0
DK estimated	0	0	0	0	0	0	0	0	0	0	0	149	9	238	0	0
SH counted	0	0	0	0	0	0	0	0	0	0	0	111	2	320	1	0
SH estimated	0	0	0	0	0	0	0	0	0	0	0	347	2	396	48	0
NS counted	0	0	0	0	0	0	0	0	0	100	0	176	2	383	26	1
NS estimated	0	0	0	0	0	0	0	0	0	528	77	1,650	4	413	65	1
NL counted	0	0	0	0	0	0	0	0	0	0	7	394	99	734	82	3
NL estimated	0	0	0	0	0	0	0	0	0	0	7	394	99	734	86	3
Total counted	**0**	**0**	**0**	**0**	0	0	**0**	**0**	**0**	**100**	**7**	**830**	**112**	**1,675**	**109**	**4**
Total estimated	**0**	**0**	**0**	**0**	0	0	**0**	**0**	**0**	**528**	**84**	**2,540**	**114**	**1,781**	**199**	**4**
Eurasian Curlew																
DK counted	140	0	0	3,937	2,128	700	7,326	5,444	7,015	8,058	8,977	873	773	4,453	0	6,022
DK estimated	1,044	3,547	5,070	4,476	2,900	1,165	7,443	5,593	7,964	8,058	8,977	873	773	4,453	1,990	6,257
SH counted	33,112	22,413	34,704	39,622	12,266	12,758	42,793	29,528	30,991	34,462	23,361	5,700	5,007	49,847	48,602	25,552
SH estimated	39,684	33,434	43,901	49,484	21,703	15,205	51,088	35,325	35,302	45,370	24,642	7,377	5,286	51,303	54,665	27,161
NS counted	46,518	45,265	58,850	81,897	50,374	14,207	40,283	21,423	35,088	24,794	35,898	15,933	4,686	66,385	63,167	39,326
NS estimated	59,045	52,431	68,425	89,671	64,293	23,021	54,156	44,763	53,689	87,189	45,347	17,742	6,756	68,616	71,571	51,691
NL counted	84,908	37,392	83,994	102,553	75,373	20,417	100,101	92,014	108,569	71,989	91,170	11,050	12,400	96,869	93,261	54,161
NL estimated	107,356	62,602	100,144	118,778	81,933	29,524	112,653	92,236	112,026	72,440	92,288	11,050	12,400	98,982	103,907	57,737
Total counted	**164,678**	**105,070**	**177,548**	**228,009**	140,141	48,082	**190,503**	**148,409**	**181,663**	**139,303**	**159,406**	**33,556**	**22,866**	**217,554**	**205,030**	**125,061**
Total estimated	**207,129**	**152,014**	**217,540**	**262,409**	170,829	68,915	**225,340**	**177,917**	**208,981**	**213,057**	**171,254**	**37,042**	**25,215**	**223,354**	**232,133**	**142,846**
Spotted Redshank																
DK counted	0	0	0	0	0	0	0	0	0	0	0	1,075	179	707	0	2
DK estimated	0	0	0	0	0	0	0	0	0	0	0	1,075	179	707	109	2
SH counted	63	0	0	36	0	0	0	12	1	0	70	9,747	2,763	8,833	2,439	448
SH estimated	63	19	0	36	0	0	0	12	1	0	272	15,730	2,772	10,088	2,468	471
NS counted	0	0	0	0	3	0	1	0	0	0	36	3,275	41	874	94	29
NS estimated	2	2	0	1	3		1	0	0	1	960	3,311	445	942	135	32
NL counted	98	0	0	2	0	0	3	6	2	43	1,658	6,590	1,609	4,726	641	115
NL estimated	100	36	2	2	0	1	6	6	4	43	1,658	6,590	1,609	4,726	1,382	115
Total counted	**161**	**0**	**0**	**38**	3	0	**4**	**18**	**3**	**43**	**1,764**	**20,687**	**4,592**	**15,140**	**3,174**	**594**
Total estimated	**165**	**57**	**2**	**39**	3	1	**7**	**18**	**5**	**44**	**2,890**	**26,706**	**5,005**	**16,463**	**4,094**	**620**

Date	18.1.1992	9.1.1993	15.1.1994	21.1.1995	*20.1.1996*	*11.1.1997*	10.1.1998	16.1.1999	22.1.2000	14.3.1998	8.4.2000	6.5.1995	12.6.1999	17.8.1996	8.10.1994	15.11.1997
Common Redshank																
DK counted	641	0	0	2,007	*1,008*	*50*	1,157	934	1,663	1,338	1,769	1,832	460	3,637	0	845
DK estimated	837	1,349	2,221	2,058	*1,064*	*131*	1,160	934	1,719	1,338	1,769	1,832	460	3,637	462	906
SH counted	3,644	2,865	4,012	1,891	*787*	*682*	2,169	733	1,486	605	3,126	3,942	4,085	10,673	4,298	1,412
SH estimated	4,470	3,681	4,704	2,389	*1,340*	*716*	2,316	932	1,584	717	3,286	4,798	4,178	11,620	4,791	1,546
NS counted	4,110	3,537	3,262	3,723	*1,803*	*173*	273	334	513	318	3,063	7,371	1,668	12,596	6,138	1,973
NS estimated	4,324	3,713	3,500	3,767	*2,215*	*352*	467	666	724	1,564	4,916	7,835	2,820	13,195	6,224	2,330
NL counted	7,342	2,894	10,991	8,636	*8,786*	*298*	3,136	7,275	6,378	5,937	13,521	8,087	5,758	25,339	11,794	5,064
NL estimated	9,383	4,920	11,815	8,820	*8,951*	*537*	4,044	7,281	6,430	5,937	13,649	8,087	5,758	25,339	13,630	5,066
Total counted	**15,737**	**9,296**	**18,265**	**16,257**	*12,384*	*1,203*	**6,735**	**9,276**	**10,040**	**8,198**	**21,479**	**21,232**	**11,971**	**52,245**	**22,230**	**9,294**
Total estimated	**19,014**	**13,663**	**22,240**	**17,034**	*13,570*	*1,736*	**7,987**	**9,813**	**10,457**	**9,556**	**23,620**	**22,552**	**13,216**	**53,791**	**25,107**	**9,848**
Common Greenshank																
DK counted	0	0	0	0	*0*	*0*	0	0	0	0	4	1,905	50	3,101	0	1
DK estimated	0	0	0	0	*0*	*0*	0	0	0	0	4	1,905	50	3,101	24	1
SH counted	0	0	0	4	*0*	*0*	25	0	0	0	8	808	111	4,009	544	60
SH estimated	5	0	0	4	*0*		25	1	0	0	8	1,223	113	4,466	768	61
NS counted	0	0	3	0	*2*	*0*	0	0	0	0	6	2,926	15	3,032	544	39
NS estimated	16	6	3	1	*2*	*0*	17	2	0		7	2,974	78	3,183	671	242
NL counted	27	2	0	0	*0*	*0*	5	4	0	0	25	2,137	47	8,748	673	110
NL estimated	27	7	1	0	*0*		6	4	0	0	26	2,137	47	8,829	947	110
Total counted	**27**	**2**	**3**	**4**	*2*	*0*	**30**	**4**	**0**	**0**	**43**	**7,776**	**223**	**18,890**	**1,761**	**210**
Total estimated	**48**	**13**	**4**	**5**	*2*	*0*	**48**	**7**	**0**	**0**	**45**	**8,239**	**288**	**19,579**	**2,410**	**414**
Ruddy Turnstone																
DK counted	0	0	0	29	*14*	*23*	86	116	252	53	210	440	4	85	0	58
DK estimated	314	362	542	605	*214*	*269*	257	320	252	53	210	440	4	85	0	58
SH counted	297	223	394	545	*50*	*50*	278	292	227	215	231	3,068	61	738	1,310	271
SH estimated	377	368	557	695	*117*	*95*	301	331	249	222	300	3,509	72	847	1,328	328
NS counted	284	659	494	1,371	*444*	*230*	111	158	271	205	287	1,762	62	597	2,075	180
NS estimated	565	933	496	1,427	*580*	*339*	150	225	323	328	297	1,767	70	603	2,602	254
NL counted	1,019	503	2,005	2,956	*1,084*	*1,407*	890	1,181	1,373	780	1,118	2,745	168	2,094	1,185	1,788
NL estimated	1,911	1,413	2,925	3,087	*1,112*	*1,643*	1,015	1,181	1,444	780	1,121	2,745	168	2,126	3,192	1,791
Total counted	**1,600**	**1,385**	**2,893**	**4,901**	*1,592*	*1,710*	**1,365**	**1,747**	**2,123**	**1,253**	**1,846**	**8,015**	**295**	**3,514**	**4,570**	**2,297**
Total estimated	**3,167**	**3,076**	**4,520**	**5,814**	*2,023*	*2,346*	**1,723**	**2,057**	**2,268**	**1,383**	**1,928**	**8,461**	**314**	**3,661**	**7,122**	**2,431**

Date	18.1.1992	9.1.1993	15.1.1994	21.1.1995	*20.1.1996*	*11.1.1997*	10.1.1998	16.1.1999	22.1.2000	14.3.1998	8.4.2000	6.5.1995	12.6.1999	17.8.1996	8.10.1994	15.11.1997
Common Black-headed Gull																
DK counted	3,155	0	0	768	*549*	*288*	2,642	1,402	311	5,352	22,456	14,940	25,759	50,734	0	1,297
DK estimated	3,290	3,728	1,631	858	*1,093*	*585*	2,656	1,403	323	5,352	22,456	14,940	25,759	50,757	5,164	1,400
SH counted	3,505	1,522	1,728	2,050	*1,042*	*1,519*	3,242	945	988	10,231	30,794	37,058	40,057	69,296	20,281	5,491
SH estimated	6,204	7,650	4,265	3,482	*3,553*	*1,637*	4,657	1,993	1,630	12,841	33,016	45,321	46,357	78,824	25,897	5,828
NS counted	5,495	10,003	6,704	6,011	*6,049*	*1,780*	6,604	3,228	1,619	6,556	27,899	20,490	21,644	122,292	49,431	6,507
NS estimated	8,158	12,159	7,276	6,599	*7,731*	*2,429*	7,656	4,796	3,311	23,122	38,271	23,765	31,620	140,880	52,703	7,655
NL counted	3,642	13,282	5,376	9,637	*9,413*	*3,451*	4,288	7,803	7,516	32,922	80,494	46,770	38,652	238,360	59,577	10,096
NL estimated	10,823	24,880	7,766	10,664	*10,469*	*3,849*	4,998	8,259	7,985	32,922	81,243	46,770	38,652	241,728	67,522	10,282
Total counted	**15,797**	**24,807**	**13,808**	**18,466**	*17,053*	*7,038*	**16,776**	**13,378**	**10,434**	**55,061**	**161,643**	**119,258**	**126,112**	**480,682**	**129,289**	**23,391**
Total estimated	**28,475**	**48,417**	**20,938**	**21,603**	*22,846*	*8,500*	**19,967**	**16,451**	**13,249**	**74,237**	**174,986**	**130,796**	**142,388**	**512,189**	**151,286**	**25,165**
Common Gull																
DK counted	38,540	0	0	9,533	*11,825*	*1,767*	14,484	9,586	7,945	13,968	5,586	2,565	12,518	26,897	0	10,283
DK estimated	44,946	24,689	19,837	12,623	*25,377*	*8,905*	17,514	12,411	9,298	13,968	5,586	2,565	12,518	27,055	7,608	10,392
SH counted	2,914	3,825	13,474	10,659	*5,469*	*2,677*	13,951	8,285	9,186	6,503	6,103	4,434	6,113	21,295	15,063	15,039
SH estimated	7,835	10,695	17,818	12,427	*13,852*	*4,175*	15,688	9,047	9,698	9,267	6,685	6,526	6,576	26,356	20,396	15,678
NS counted	2,927	24,499	22,027	20,052	*22,156*	*3,206*	13,523	7,226	6,971	3,965	1,781	2,164	1,600	54,667	29,210	5,615
NS estimated	7,872	33,151	23,530	21,950	*31,775*	*8,953*	18,893	15,167	10,098	20,337	3,542	2,365	4,025	67,396	32,340	9,504
NL counted	23,281	28,348	19,997	21,220	*61,629*	*31,351*	32,598	46,135	21,321	27,820	20,766	4,275	8,407	136,888	38,052	14,126
NL estimated	32,668	45,043	28,284	25,583	*64,619*	*37,718*	35,759	46,740	21,825	27,820	20,929	4,275	8,407	137,411	49,884	14,302
Total counted	**67,662**	**56,672**	**55,498**	**61,464**	*101,079*	*39,001*	**74,556**	**71,232**	**45,423**	**52,256**	**34,236**	**13,438**	**28,638**	**239,747**	**82,325**	**45,063**
Total estimated	**93,321**	**113,578**	**89,469**	**72,583**	*135,623*	*59,751*	**87,854**	**83,365**	**50,919**	**71,392**	**36,742**	**15,731**	**31,526**	**258,218**	**110,228**	**49,876**
Herring Gull																
DK counted	22,712	0	0	18,019	*9,097*	*7,518*	30,538	26,987	27,542	18,394	11,273	11,870	25,739	23,075	0	14,635
DK estimated	34,349	40,776	40,869	35,547	*28,013*	*12,723*	51,796	45,681	29,473	18,394	11,273	11,878	25,739	23,349	16,910	15,501
SH counted	21,080	5,667	10,065	10,682	*10,884*	*1,793*	20,303	8,711	18,372	15,971	15,185	21,314	25,974	40,770	27,798	14,659
SH estimated	23,635	24,776	26,419	24,649	*24,816*	*4,635*	41,243	23,813	26,741	21,243	16,226	26,510	28,715	42,938	37,377	16,067
NS counted	13,406	26,384	32,411	36,983	*9,501*	*3,928*	38,355	17,684	17,008	7,064	15,434	14,115	17,369	64,473	55,624	23,182
NS estimated	19,608	37,396	35,431	40,503	*22,521*	*5,906*	44,030	33,310	22,508	62,036	17,968	19,107	23,520	67,008	63,711	30,786
NL counted	20,969	43,894	46,349	65,391	*60,910*	*13,441*	71,906	102,566	35,131	76,902	40,619	23,775	24,237	120,712	78,817	25,649
NL estimated	41,296	76,831	73,896	81,167	*69,271*	*17,778*	84,232	103,994	39,692	77,109	41,061	23,908	24,237	121,196	110,623	26,618
Total counted	**78,167**	**75,945**	**88,825**	**131,075**	*90,392*	*26,680*	**161,102**	**155,948**	**98,053**	**118,331**	**82,511**	**71,074**	**93,319**	**249,030**	**162,239**	**78,125**
Total estimated	**118,888**	**179,779**	**176,615**	**181,866**	*144,621*	*41,042*	**221,301**	**206,798**	**118,414**	**178,782**	**86,528**	**81,403**	**102,211**	**254,491**	**228,621**	**88,972**

Date	18.1.1992	9.1.1993	15.1.1994	21.1.1995	*20.1.1996*	*11.1.1997*	10.1.1998	16.1.1999	22.1.2000	14.3.1998	8.4.2000	6.5.1995	12.6.1999	17.8.1996	8.10.1994	15.11.1997
Greater Black-backed Gull																
DK counted	540	0	0	1,320	*219*	*784*	2,113	2,383	894	942	479	658	1,721	1,934	0	1,795
DK estimated	654	1,167	1,439	1,513	*615*	*948*	2,521	2,721	936	942	479	658	1,721	1,935	184	1,823
SH counted	392	348	846	634	*204*	*113*	1,051	1,312	844	588	373	239	246	997	1,940	555
SH estimated	473	841	1,372	995	*561*	*262*	1,903	1,992	1,175	724	384	328	261	1,214	2,127	686
NS counted	239	483	1,341	1,519	*263*	*75*	824	1,343	643	139	44	30	46	712	1,287	572
NS estimated	424	907	1,483	1,602	*626*	*214*	1,452	2,289	925	838	114	70	63	837	1,328	946
NL counted	1,564	2,403	2,847	3,081	*4,119*	*1,525*	9,278	11,090	4,901	2,152	574	283	345	5,235	2,827	6,382
NL estimated	3,137	5,172	5,573	4,343	*4,375*	*2,124*	11,736	11,349	5,793	2,152	574	283	345	5,241	4,553	7,233
Total counted	**2,735**	**3,234**	**5,034**	**6,554**	*4,805*	*2,497*	**13,266**	**16,128**	**7,282**	**3,821**	**1,470**	**1,210**	**2,358**	**8,878**	**6,054**	**9,304**
Total estimated	**4,688**	**8,087**	**9,867**	**8,453**	*6,177*	*3,548*	**17,612**	**18,351**	**8,829**	**4,656**	**1,551**	**1,339**	**2,390**	**9,227**	**8,192**	**10,688**

Annex 3: Glossary

Temporal terms

Bird days

The total of the daily bird numbers for one ore more species, for a given time period (i.e. a season or a year) and for one or more counting units.

As the birds are usually not counted daily, the „bird days" must be calculated with the data available; gaps between counts should not exceed 30 days.

Bird days =
(number of birds per day) x (number of days)

For a day without a count, the "number of birds per day" is the arithmetic mean of the last count before and first count after this day.

"Bird days" shall not be calculated if the time between two counts becomes too long, in particular during periods of large fluctuations.

From a scientific point of view the "bird days" give a very good estimate of the total use on an area instead of using the maximum number.

Bird year

In the Wadden Sea, the year for migratory waterbirds goes from July of one year to June of the following year. Therefore, it includes only juveniles from one breeding season and only one type of winter (i.e. cold / normal or mild).

Half-month period

Each month can be divided into two half-month periods covering "01 to 15" and "16 to the end" of a given month.

Spring tide

A tide which is greater than the average level and which occurs about every 15 days, when the moon is full or new. In the Wadden Sea, this actually occurs on average three days after a full or new moon.

Spatial terms

Counting unit

A geographically well defined area with fixed borders in which one or more counters count the number of birds present (see also spring tide counting site) and which can be counted during one high tide (usually < 3 hours). The smallest area for which data are collected. Usually the birds tend to stay within a "counting unit" during the high tide period.

Sidecode (national sidecode)

Each counting unit has a unique sitecode; these sidecodes are assigned by each country following their own rules.

Spring tide counting site

One or more counting units selected for long-term monitoring in which waterbirds are counted at each spring tide.

Tidal Unit

The Wadden Sea is divided into 29 such units, each of which covers an ecological unit of tidal flats and their adjacent roosting sites (i.e. a number of counting units). Note: This concept is not equal to the „tidal basins" used for other projects, as they consist of a tidal inlet with adjacent parts of the mudflats up to the water divide. However, for migratory waterbirds usually the mudflats are much more relevant, therefore, a "tidal unit", as used here, consists of a mudflat area with the adjacent parts of the tidal inlets (Meltofte et al., 1994).

Wadden Sea

Our study area. It is the coastal region between Blåvands Huk in Denmark and Den Helder in the Netherlands. It generally equals the so-called „Cooperation Area" of the three countries. For ecological reasons, it includes the North Sea directly adjacent to the islands and sandbanks and the inland polders directly adjacent to the sea dike or, where there are no polders, the area adjacent to the salt marsh or the high tide line (see Figure 2.1).

Types of count

Synchronous count

A count of waterbirds carried out in all counting units in the entire Wadden Sea on the same day or close to the same day, with the aim to measure the total number of birds present at that time (also called „total counts").

Midwinter count

A special synchronous count of all waterbirds in the entire Wadden Sea in January.

Goose count

A special synchronous count of one or all goose species in the Wadden Sea, including marshland areas further inland from the polders adjacent to the dike.

Spring tide count

A count of waterbirds in the spring tide counting sites during or close to the time of the spring tide.

Aerial counts

Counts of specific species, groups of species or all waterbirds from an airplane (altitude 150-200 m) (Eider, Shelduck & Common Scoter at low tide in all channels in the Wadden Sea and in the North Sea adjacent to the Wadden Sea) (other species at high tide in the Wadden Sea).

Analysis

Maximum number

The highest number counted for a species in one ore more counting units within a certain time period. Note: This is not necessarily the real maximum number of birds using the area, as there may usually be some turnover (i.e. the first birds having left the area while others still arrive). Also, there may be a time when the number of birds actually present is higher than at the time during a count.

Imputed value

A calculated value for a missing number of birds (i.e. a species not counted in one or more counting units for a given date). There are several statistical methods available for this, being also further developed. Though imputing is required for many of our calculations, the proportion of the results which have been imputed must be kept as small as possible to keep the error implied as small as possible.

Phenology

Description of the annual variation of species numbers in one or more counting units, usually based on the average number for each half-month period for a number of years

Other terms

Counter

The person counting birds in the field.

National coordinator

The person who coordinates the migratory bird monitoring for a country or a federal state (i.e. Denmark, Schleswig-Holstein, Niedersachsen & Hamburg, the Netherlands)

Waterbirds

Species of birds that are ecologically dependent on wetlands. For the Wadden Sea, these belong usually to the families Gaviidae, Podicipedidae, Phalacrocoracidae, Ardeidae, Threskiornithidae, Anatidae, Rallidae, Haematopodidae, Recurvirostridae, Charadriidae, Scolopacidae and Laridae. For practical purposes other migratory species which are important for the Wadden Sea are added such as Peregrine Falcon, Snow Bunting, Shorelark and Twite. However, although all waterbirds observed are also counted, it is usually a short list of the more abundant species which are analyzed for their distribution and trend.

Ramsar criteria

Relate to the international „Ramsar Convention";

Criterion 5: A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.

Criterion 6: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbirds.

Ramsar factor

The percentage of the individuals in a population of one species or subspecies of waterbirds, which have maximally been counted in one or more counting units.

JMMB

Abbreviation for the „Joint Monitoring of Migratory Birds"-Program in the Wadden Sea, being part of the Trilateral Monitoring and Assessment Program (TMAP) and being the basis for this report.

The JMMB-Group is the National Coordinator Group on the Joint Monitoring of Migratory Birds program in the Wadden Sea.

WADDEN SEA ECOSYSTEM No. 20

Recent Population Dynamics and Habitat Use of Barnacle Geese and Dark-bellied Brent Geese in the Wadden Sea

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Contents

Summaries

Summary

The Wadden Sea is an important staging area for the Russian-Baltic population of Barnacle Geese (*Branta leucopsis*) and the West-Siberian population of Dark-bellied Brent Geese (*Branta b. bernicla*). Both species use the Wadden Sea mainly in spring and autumn as a staging area to accumulate body reserves for migration and breeding. Smaller numbers stay during winter. Data from trilateral goose counts and regular census data was used to review the current status of both species, especially with regard to numbers, phenology and habitat.

In the 1990s, up to 85% of the Russian-Baltic flyway population of Barnacle Geese concentrated in the area in March. Moreover, as a result of the ongoing population increase, numbers and feeding range in the Wadden Sea have expanded considerably, especially in spring and mainly along the mainland coast. This coincided with a delay in spring departure of 4-6 weeks; the last birds leave the area around Mid-May, and probably head directly for their breeding areas from the White Sea and further east. Compared to the 1980s and earlier, the Wadden Sea has grown in importance as a pre-migration area, where body reserves are stored for spring migration and breeding.

In Dark-bellied Brent Goose on the other hand, numbers have declined since the mid-1990s. The decline in the Wadden Sea runs parallel to an overall population decrease, which has been caused by lower reproduction rates at the breeding areas. However, in spring about 85% of the population is still found in the Wadden Sea, whereas in winter only 10% of the population is present. As a result of the lower population level, Dark-bellied Brent Geese have contracted their main feeding sites to the barrier islands.

For both species, the overall changes in numbers, distribution and habitat utilization in the Wadden Sea seem to be mainly related to changes at population level. No evidence has been found that changes in feeding and staging conditions in the Wadden Sea have contributed to the decline and increase in either species. However, further research, such as analysis of movements of color-marked birds could help to understand some of the observed changes in distribution and phenology. In the coming years, further expansion of feeding areas in the Wadden Sea and its immediate surroundings, *i.e.* agricultural areas along the mainland coast, polders on the islands and other sites outside the Wadden Sea is likely for Barnacle Geese, and potential conflicts with farmers might increase.

Sammenfatning

Vadehavet er et vigtigt rasteområde for den russisk-baltiske bestand af Bramgås (Branta leucopsis) og den Vestsiberiske bestand af Mørkbuget Knortegås (Branta b. bernicla). Begge arter bruger især Vadehavet om foråret og efteråret som rasteområde til pålejring af fedtreserver til deres træk- og yngleaktivitet. Et mindre antal

fugle bliver i Vadehavet om vinteren. Data fra de trilaterale gåsetællinger og regelmæssige optællinger er brugt til at revidere arternes nuværende status, især med hensyn til antal, fænologi og habitat.

I 1990erne var op mod 85% af den russisk-baltiske bestand af Bramgæs koncentreret i Vadehavet i marts måned. Desuden, som et resultat af den stigende bestand, er antal og fødesøgningsområde i Vadehavet udvidet betydeligt, specielt om foråret og især langs fastlandskysten. Dette falder sammen med en udsættelse af forårstrækket til yngleområderne med 4-6 uger; de sidste fugle forlader nu området omkring midten af maj, disse fugle flyver sandsynligvis direkte til yngleområderne ved Hvidehavet og længere østpå. Sammenlignet med 1980erne og tidligere, er Vadehavets betydning steget betydeligt som et før-træk område, hvor krops-reserverne bliver fyldt til forårstrækket og yngleaktiviterne.

Antallet af Mørkbuget Knortegås er faldet i antal siden midten af 90erne. Nedgangen i antallet i Vadehavet løber parallelt med en overordnet bestands nedgang, som skyldes lav ynglesucces. På den anden side er 85% af bestanden stadig i Vadehavet, hvorimod kun 10% er tilstede om vinteren. Som et resultat af det lave bestandsniveau, har Mørkbuget Knortegås koncentreret deres fødesøgningsområder på øerne i Vadehavet.

For begge arter er den overordnede ændring i antal, fordeling og habitatudnyttelse i Vadehavet især relateret til ændringen på bestandsniveau. Der er ikke fundet evidens for at der er ændringer i føde- eller rastebetingelserne i Vadehavet, som har bidraget til faldende eller stigende antal for nogle af arterne. Imidlertid kan øget forskning i form af analyser af fuglenes bevægelser ved farvemærkning af individerne kunne hjælpe med til at forstå nogle af de observerede ændringer i fordeling og fænologi. I de kommende år er det sandsynligt at der for Bramgæs vil ske en yderligere ekspansion i fødesøgningsområderne i Vadehavet og i dets umiddelbare omgivelser, f.eks. i landbrugsområder langs fastlandskysten, marskområder på øerne og i andre områder udenfor Vadehavet. Dette kan medføre stigende konflikter med landmænd.

Zusammenfassung

Das Wattenmeer ist ein bedeutendes Rastgebiet für die russisch-baltische Population der Nonnengans (*Branta leucopsis*) und der Dunkelbäuchigen Ringelgans (*Branta b. bernicla*). Beide Arten nutzen das Wattenmeer vor allem im Frühjahr und Herbst, um sich Fettreserven für die weiten Zugstrecken und die Brutzeit anzufressen und zu einem geringeren Anteil auch als Überwinterungsgebiet. Zähldaten der wattenmeerweiten Gänse-Synchronzählungen und der anderen regelmäßigen Zählungen wurden ausgewertet, um einen aktuellen Überblick über den Status beider Arten im Hinblick auf die Bestandsgrößen, die jahreszeitliche Verteilung und die Habitatnutzung zu geben.

In den 1990er Jahren rasteten im März bis zu 85% der russisch-baltischen Nonnengans-Population im Wattenmeergebiet. Als Folge des anhaltenden Populationswachstums, vergrößerte sich sowohl die Zahl der im Wattenmeer rastenden Gänse deutlich, als auch die von ihnen genutzte Fläche, vor allem im Frühjahr entlang der Festlandsküste. Dies wird auch durch einen nun um 4-6 Wochen späteren Abzug deutlich – die letzten Vögel verlassen das Wattenmeergebiet Mitte Mai und ziehen wahrscheinlich direkt in ihre Brutgebiete am Weißen Meer und weiter östlich. Verglichen mit der Zeit vor den 90er Jahren hat die Bedeutung des Wattenmeeres für die Nonnengänse als vorbrutzeitliches Rastgebiet zur Anlage von Fettreserven für Zug und Brut zugenommen.

Bei der Dunkelbäuchigen Ringelgans dagegen haben die Bestände seit Mitte der 1990er Jahre nicht nur im Wattenmeer, sondern in der gesamten Population deutlich abgenommen, was wahrscheinlich vor allem an dem schlechten Bruterfolg der letzten Jahre liegt. Weiterhin rasten aber im Frühjahr etwa 85% der Population im Wattenmeer, während es im Winter nur 10% sind. Als Folge der geringeren Populationsgröße haben sich die Ringelgänse wieder auf die Salzwiesen der Halligen und Inseln als ihre Hauptnahrungshabitate konzentriert.

Für beide Arten gilt wohl, dass die Veränderungen der Anzahl, der Verteilung und Habitatnutzung im Wattenmeer vor allem mit den Bestandsveränderungen der Populationen zusammenhängt. Es gibt keine Anzeichen, dass Veränderungen der Ernährungs- und Rastbedingungen im Wattenmeer auf die Zu- oder Abnahme der Populationsgröße der beiden Arten einen Einfluss gehabt hätten. Weitere Untersuchungen, wie die Beobachtung der Raumnutzung farbmarkierter Vögel könnten helfen, einige der beobachteten Veränderungen in der räumlichen und jahreszeitlichen Verteilung besser zu verstehen. In den kommenden Jahren könnte es bei den Nonnengänsen möglicherweise zu einer Ausweitung der Nahrungsgebiete im Wattenmeer und in angrenzenden Gebieten entlang der Festlandsküste und auf Inseln kommen, was Konflikte mit der Landwirtschaft vergrößern könnte.

Samenvatting

De Waddenzee is van groot belang voor doortrekkende en overwinterende Brandganzen (*Branta leucopsis*) uit het Oostzeegebied en de Russische Arctis en de West-Siberische populatie Rotganzen (*Branta bernicla)*. Beide soorten gebruiken het gebied vooral als tussenstation (opvetgebied) tijdens de voorjaarstrek; kleinere aantallen brengen ook de winter door in het Waddengebied. Dit hoofdstuk beschrijft het voorkomen van beide soorten aan de hand van de speciale ganzentellingen en reguliere hoogwatertellingen van alle soorten die plaatsvinden in het kader van het Trilateral Monitoring and Assessment Program (TMAP). Aan de orde komen aantallen, seizoensvoorkomen en habitat en de ontwikkelingen daarin in de afgelopen decennia.

In de jaren negentig verbleef tot 85% van de Russisch-Baltische populatie in de Waddenzee bij aanvang van de voorjaarstrek in maart. Door de aanhoudende populatiegroei breidde tegelijkertijd het aantal pleisterplaatsen zich steeds verder uit, zowel in de Waddenzee zelf als ook in gebieden in het binnenland. Tevens schoof de vertrekdatum steeds verder naar eind april; tegenwoordig vertrekken Brandganzen maar liefst 4-6 weken later uit de Waddenzee als eind jaren tachtig. Ze vliegen dan vermoedelijk direct naar de Russische Arctis. Voorheen maakten deze vogels nog een tussenstop in het Baltisch gebied. Net als voor de Rotgans, speelt de Waddenzee tegenwoordig dus ook voor Brandganzen een prominente rol als opvetgebied voor de voorjaarstrek en het broedproces.

Tegelijk met de groei van het aantal Brandganzen, nam het aantal Rotganzen in de Waddenzee af. Deze afname bleef niet beperkt tot het Waddengebied, maar is een gevolg van een algehele afname van de populatie. Deze ontwikkeling wordt ingegeven door een lange reeks van jaren met slechte broedresultaten waarvan de oorzaak (nog) niet bekend is. Ondanks de kleinere aantallen wordt in het voorjaar (mei) nog steeds 85% van de rotganzenpopulatie in de Waddenzee aangetroffen. In de winter daarentegen, worden maar weinig vogels waargenomen. Hooguit 10% van de populatie verblijft dan in het Waddengebied, met name in het Nederlandse deel dat klimatologisch gunstiger afsteekt tegen de Duitse en Deense Waddenzee. Door de kleinere aantallen Rotganzen heeft zich een opvallende verschuiving voorgedaan in de verspreiding. Tegenwoordig verblijft een belangrijk deel van de vogels op de eilanden.

De ontwikkelingen in voorkomen en habitatgebruik van beide soorten zijn vooral gevolg van ontwikkelingen die zich op populatieniveau hebben afgespeeld. Er zijn geen aanwijzingen gevonden dat factoren in de Waddenzee zelf mede verantwoordelijk zijn voor de waargenomen trends. Niettemin kunnen verdere analyses licht werpen op achtergronden van verschuivingen in verspreiding en seizoensverloop. In de komende jaren wordt bovendien een verdere toename verwacht van het aantal Brandganzen, waarbij de vogels tegelijk ook hun voedselterreinen zullen uitbreiden. Dit brengt mogelijk nieuwe conflicten met zich mee met de landbouw.

1. Introduction

The Wadden Sea region is an important staging area for Arctic geese. Especially in late winter and spring, a major part of the Russian-Baltic population of Barnacle Geese and the West-Siberian population of Dark-bellied Brent Geese concentrates in the Wadden Sea to accumulate body reserves for spring migration and breeding (Ebbinge and Spaans, 1995; Ebbinge *et al.*, 1999; Ganter *et al.*, 1999). During autumn and winter, the region is used by smaller numbers as a stopover site or wintering area. Both species have benefited from improved protection measures and changes in agricultural practice (Ebbinge, 1991; van Eerden *et al.*, 1996) and have experienced long-term increases since the 1960s. Whilst Barnacle Geese still show an ongoing population growth, the numbers of Dark-bellied Brent Geese have declined recently (Ebbinge *et al.*, 2002). Geese are herbivores and nowadays preferably feed on grass-dominated vegetation. In the Wadden Sea, they are mainly found on the salt marshes. Especially after arrival in autumn, Dark-bellied Brent Geese also feed on eelgrass (*Zostera*) and green algae (*Ulva* and *Enteromorpha*) in the intertidal area. In late autumn and winter, large numbers of Barnacle- and Dark-bellied Brent Geese switch to feed on fertilized pastures at agricultural sites behind the seawall. This occurs mainly in the western part of the Wadden Sea (Niedersachsen and The Netherlands), which supports important wintering concentrations.

Goose grazing has been subject to many controversial discussions. At inland agricultural sites, conflicts with farming are common and various management measures are taken to provide solutions for the co-existence of farmers and geese (van Roomen and Madsen, 1992; Laursen, 2002; Ebbinge *et al.*, 2003). On salt marshes, the role of livestock grazing and the responses of geese to various grazing and management regimes have been studied in detail (*e.g.* van der Wal, 1998; Esselink, 2000; Stock and Kiehl, 2000; Bergmann and Borbach-Jaene, 2001; Stahl, 2001; Bos, 2002; Stock and Hofeditz, 2002; Weigt *et al.*, 2002). Part of these studies have been carried out to detect changes in goose numbers and distribution as a result of the reduction in livestock grazing at salt marshes. In Schleswig-Holstein and Niedersachsen, grazing by sheep and cattle was abandoned in approx. 50% and 60% of the mainland salt marshes respectively, after the establishment of national parks around 1990 (Remmers, 2003; Stock, 2003). In the Dutch Wadden Sea, about 60% of the mainland salt marshes has not been grazed since the 1980s, whereas in Denmark grazing is absent in only 15% of the salt marsh area (Bos *et al.*, in prep.). These management changes have prompted debate with respect to the habitat-conservation of natural salt marshes and species conservation of Barnacle- and Dark-bellied Brent Geese, which are sometimes regarded as contradiction (Bergmann and Borbach-Jaene, 2001; Lutz *et al.*, 2003).

In order to provide a framework for goose management in the Wadden Sea, this chapter aims to present a general review of goose numbers and habitat use of Barnacle Geese and Dark-bellied Brent Geese. In the past decade, numbers, distribution and staging habits of both species have been subject to major changes. Since numbers and trends have been described already in Chapter 7 in Blew *et al.*, 2005 (this volume), this review will focus on the backgrounds of the developments observed and highlight relationships between numbers in the Wadden Sea and trends in the overall population. Furthermore changes in habitat use, phenology and related processes will be discussed and implications for management will be given.

2. Data and Methods

Major parts of the data analyzed in this chapter have been retrieved from the trilateral synchronous goose censuses which are carried out annually in January (both species), March (Barnacle Goose) and early May (Dark-bellied Brent Goose). For phenology, data from spring tide counting sites was also used; these are counted every two weeks during spring tide (see Chapter 6.2.3. in Blew *et al.*, 2005, this volume). Brent Goose numbers always refer to Dark-bellied Brent Geese *Branta b. bernicla.* Light-bellied Brent Geese *Branta b. hrota* occur regularly only in the Danish Wadden Sea (Clausen *et al.*, 1996), and have been left out in this review. Methods and data management of the trilateral counts have been described in detail by Blew *et al.*, 2005 (this volume). Additional data was taken from the national census schemes in The Netherlands (*e.g.* Sovon Ganzen en Zwanenwerkgroep, 2001; van Roomen *et al.*, 2004), Niedersachsen (*e.g.* Krüger, 2001; Kruckenberg and Borbach-Jaene, 2003; Borbach-Jaene *et al.*, 2002; Umland, 2003) and Schleswig-Holstein (*e.g.* Günther and Rösner, 2000; Günther, 2005). These counts were also used to estimate annual population sizes for Barnacle and Dark-bellied Brent Geese, in order to allow a comparison of Wadden Sea numbers and size of the flyway population (see also Günther, 2005). Habitat information was obtained from the recent review of high-tide roosts in the Wadden Sea (Koffijberg *et al.*, 2003).

3. Results

3.1 Numbers and trends

3.1.1 Barnacle Goose

As shown in the species accounts, the occurrence of Barnacle Geese in the Wadden Sea has been subject to a marked increase (Figure 4.4 in chapter 4 in Blew *et al.*, 2005, this volume). There is a strong relationship between the total numbers of geese observed in the Wadden Sea throughout the year and the size of the flyway population (Figure 1), especially in Denmark (total numbers), Schleswig-Holstein (spring and total numbers) and The Netherlands (autumn, spring and total numbers). During winter (December-February), there is no close relationship, probably because wintering numbers in the Wadden Sea are much smaller and primarily determined by winter temperatures and lower food quality and quantity of the salt marsh vegetation compared to the fertilized grasslands at agricultural inland sites (see discussion). At staging sites outside the Wadden Sea numbers have also increased in winter, as expressed, for example, by the counts in the Dutch province of Friesland (Figure 2). In Niedersachsen, the increase of Barnacle Geese was also mainly reported from inland areas, such as the Rheiderland (Dollart), Krummhörn and Westermarsch area (Leybucht), Jadebusen and Lower Elbe estuary (Kruckenberg *et al.*, 1996; Bergmann and Borbach-Jaene, 2001; Krüger, 2001; Kruckenberg and Borbach Jaene, 2003; Borbach-Jaene *et al.*, 2002; Umland, 2003). Although the birds feeding in these areas do roost

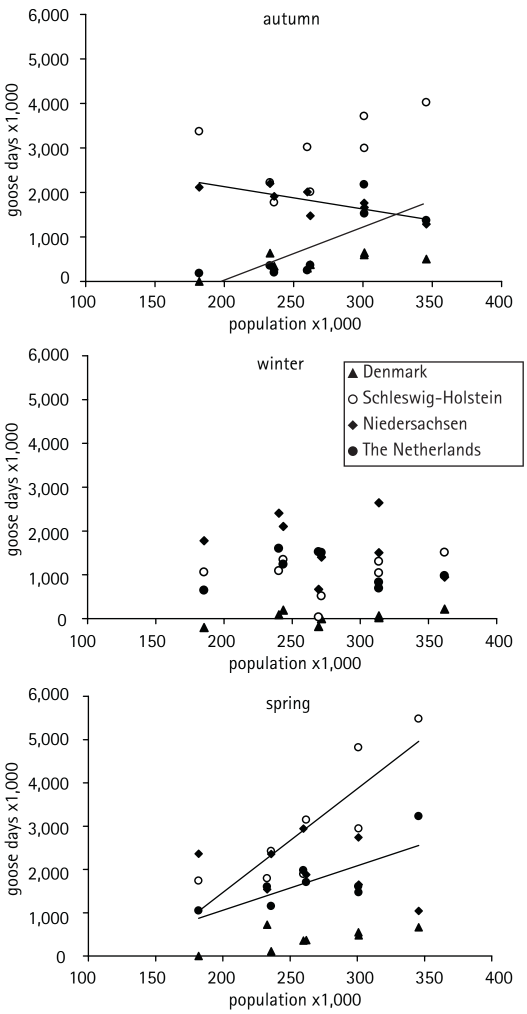


Figure 1: Population trend for Barnacle Geese in the Wadden Sea in relation to size of the flyway population, shown for autumn (September-November), winter (December-February) and spring (March-May). For Denmark data from spring tide counting sites was used, for the other countries data from all (monthly) counts. Regression lines indicate significant relationships, which were found for Schleswig-Holstein in spring (R^2 = 0.73, P = 0.007) , Niedersachsen in autumn (R^2 = 0.64, P = 0.017) and The Netherlands in autumn (R^2 = 0.58, P = 0.027) and spring (R^2 = 0.59, P = 0.027).

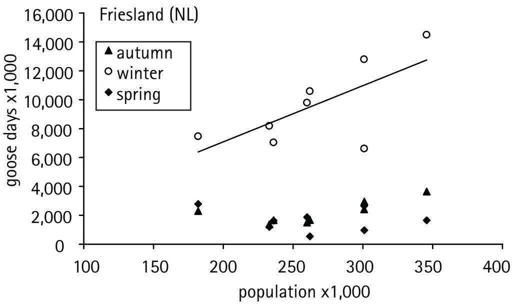


Figure 2: Population trend for Barnacle Goose (goose days from monthly counts) in the Dutch province of Friesland, which is one of the main wintering site in The Netherlands, in relation to size of the flyway population in autumn, winter and spring (see Figure 1 for period). Regression lines indicate significant relationships, which were found only for winter ($R^2 = 0.47$, $P = 0.050$).

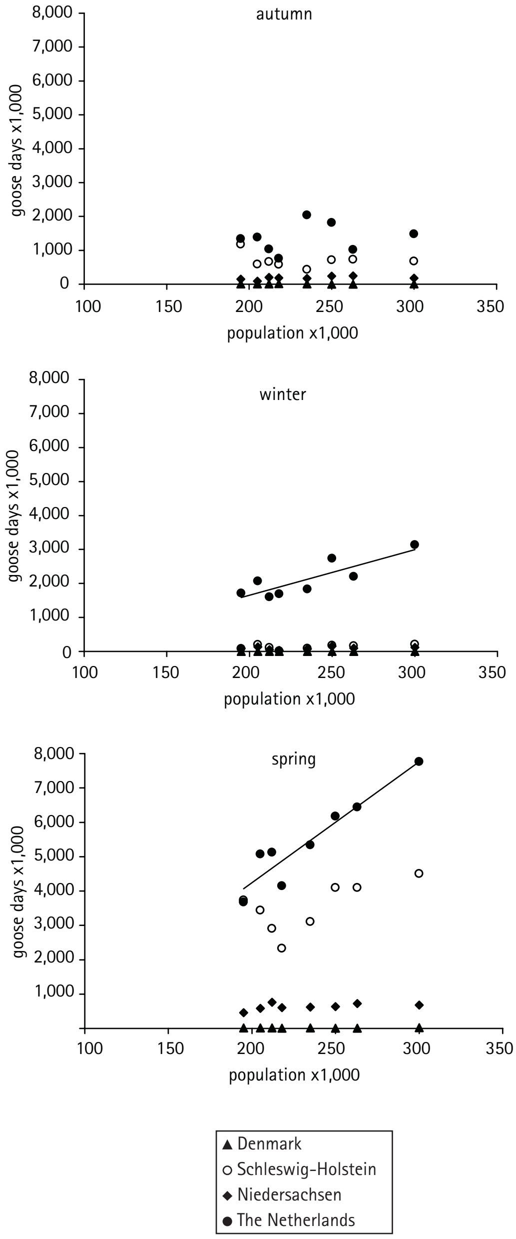


Figure 3: Population trend for Dark-bellied Brent Geese in the Wadden Sea in relation to size of the flyway population, shown for autumn, winter and spring (see Figure 1 for period and data). Regression lines indicate significant relationships, which were found for The Netherlands in winter ($R^2 = 0.72$, $P = 0.001$) and spring ($R^2 = 0.89$, $P = 0.001$).

in the Wadden Sea, their feeding areas are not part of the Wadden Sea cooperation area, and are not included in the number of goose days in Figure 1. Unlike the three other sections of the Wadden Sea, the numbers on salt marshes in Niedersachsen therefore do not show a clear relationship (or negative relationship, in autumn) with the growth of the flyway population as this development mainly occurs just outside the cooperation area at inland agricultural sites.

3.1.2 Dark-bellied Brent Goose

Traditionally, Dark-bellied Brent Geese especially concentrate in the Wadden Sea during spring migration. Peak numbers in April/May have shown a substantial decline since 1996 (Figure 4.5 in chapter 4 in Blew *et al.*, 2005, this volume) The timing and progress of this development is in line with a reduction of about 30% of the West-Siberian flyway population (Ebbinge *et al.*, 2002). Especially lower spring numbers in Schleswig-Holstein and The Netherlands, which represent the core staging regions in the Wadden Sea, correspond well with the decreased overall population size, although for Schleswig-Holstein no significant relationship could be detected (Figure 3). In winter, only numbers in The Netherlands show a clear trend with the size of the flyway population. In other parts of the Wadden Sea numbers in this time of the year are very small and fluctuate greatly according to winter weather, which makes it difficult to detect any substantial changes. This is similar in autumn, when the geese mainly pass en route to their wintering areas in England and France.

3.2 Phenology

3.2.1 Barnacle Goose

In the past decades, Barnacle Geese occurred in the Wadden Sea mainly in October-November and February-March (Smit and Wolff, 1983; Meltofte *et al.*, 1994). The phenology in the 1990s still shows these two distinct peaks (Figure 4). However, since the 1980s Barnacle Geese have shown a delay in their spring departure from the Wadden Sea of about 4-6 weeks (Koffijberg *et al.*, 1997; Stock and Hofeditz, 2002; Günther, 2005). Data from spring tide counting sites indicates that even during the last ten years, the peak of spring migration shifted from the end of March and beginning of April to the second half of April. The delay in spring departure dates becomes even more pronounced when looking at site level. At Hamburger Hallig and nearby Beltringharder Koog in Schleswig-Holstein for example, departure dates between 1988 and 2003 shifted from about the 1 April to the 15 May, *i.e.* a delay of more than six weeks within 15 years (Figure 5). Currently, the last flocks abandon this area between 15 and 20 May, just before the Dark-bellied Brent Geese start to leave. A similar pattern with nearly synchronous departure dates as observed at Schleswig-Holstein, has recently been reported from the Dollart area at the border of Niedersachsen and The Netherlands (K. Koffijberg, in prep.). Besides the delay in spring departure, Barnacle Geese also arrive earlier in spring in the northern part of the Wadden Sea nowadays, with numbers in Denmark already building up in the second half of February (Figure 4). In autumn, earlier arrival of large numbers has been reported in Schleswig-Holstein

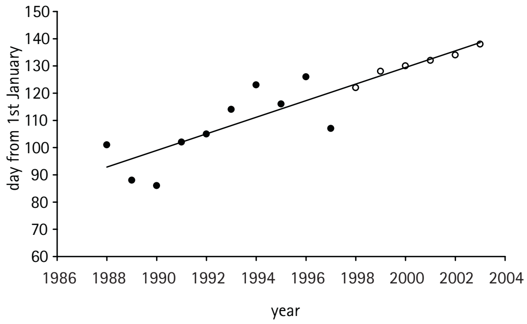


Figure 5 (top):
Departure of Barnacle Geese from the Hamburger Hallig, Schleswig-Holstein (redrawn after Stock and Hofeditz, 2002 and updated with unpublished data from K. Günther). Departure was defined as the day 75% of the population had left the area (based on spring tide counts); data from 1998 onwards refers to observed departure dates. The significant relationship is expressed by the regression line ($R^2 = 0.81$, $P < 0.001$).

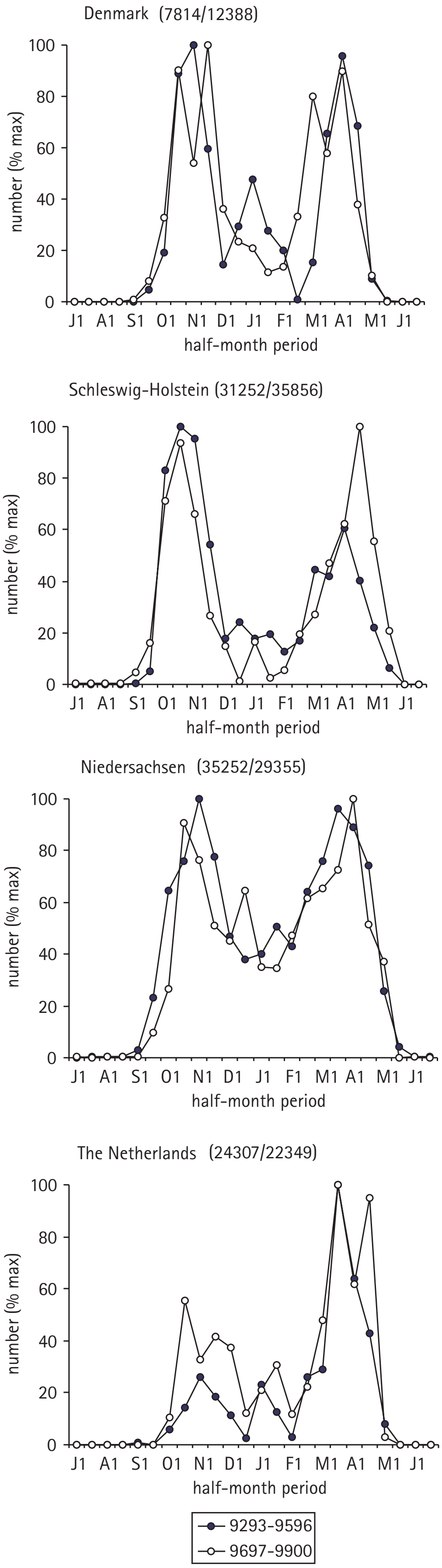


Figure 4:
Phenology of Barnacle Geese in the Wadden Sea in 1992/93-1995/96 and 1996/97-1999/2000 (from June to July). Data was derived from spring tide counting sites and numbers shown are relative to the maximum number observed. Data in parentheses after each country shows this maximum in both periods.

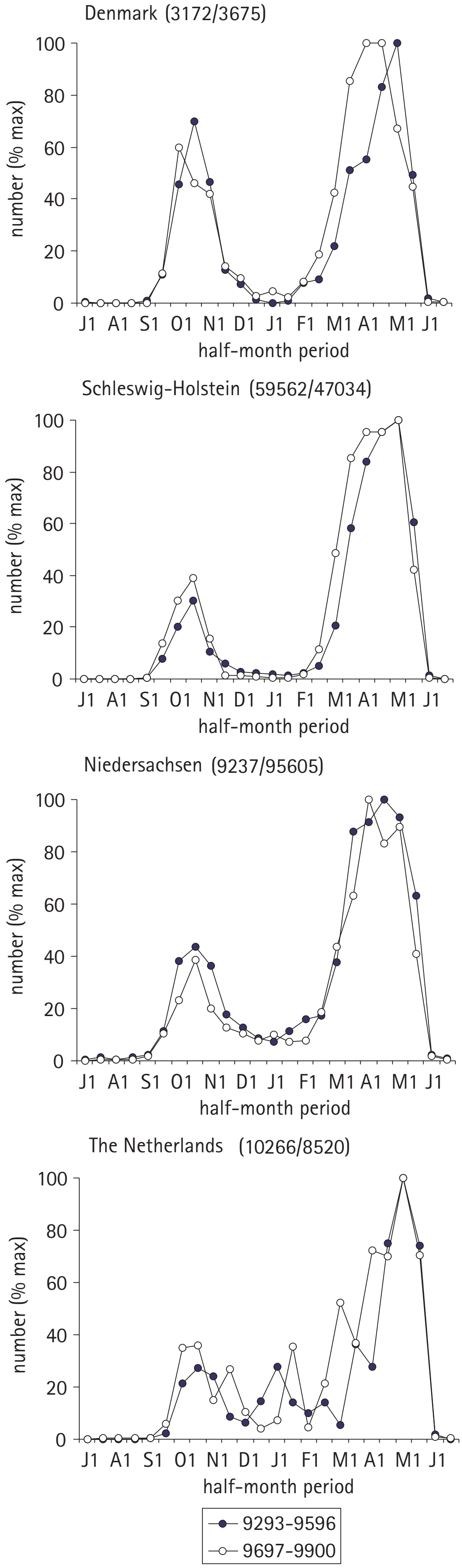


Figure 6: Phenology of Dark-bellied Brent Geese in the Wadden Sea in 1992/93-1995/96 and 1996/97-1999/2000 (from July to June). Data was derived from spring tide counting sites and numbers shown are relative to the maximum number observed. Data in parentheses after each country shows this maximum in both periods.

(Günther, 2005). Baltic breeding birds (recognizable by individually marked birds) arrive currently around mid-September, whereas Russian breeding birds have shifted their arrival from mid-October to the beginning of October. A similar pattern was observed in The Netherlands in the second half of the 1990s, which has also increased the number of goose days in the Dutch Wadden Sea in autumn (Figure 1).

5.2.2 Dark-bellied Brent Goose

Previous data has shown that Dark-bellied Brent Geese quickly move through the Wadden Sea on their way to wintering sites in southern England and western France. From March to May they return in high numbers to gain body reserves for spring migration to the stop-over sites in the White Sea and breeding at the Taimyr peninsula (Smit and Wolff, 1983; Meltofte *et al.*, 1994; Ebbinge and Spaans, 1995). These movements are still reflected by the current phenology (Figure 6). Apart from Denmark, where autumn and spring numbers are more equal, the seasonal changes in numbers are rather synchronized throughout the Wadden Sea. In Denmark, Schleswig-Holstein and in The Netherlands, the onset of the increase in spring tended to be slightly earlier and shifted from March to the second half of February. Also, peak numbers seem to occur slightly earlier in the second half of the 1990s, with maximum numbers peaking already in April. Previously, largest numbers were always counted in May (*e.g.* Rösner and Stock, 1995). Final departure dates in the second half of May, however, have not changed.

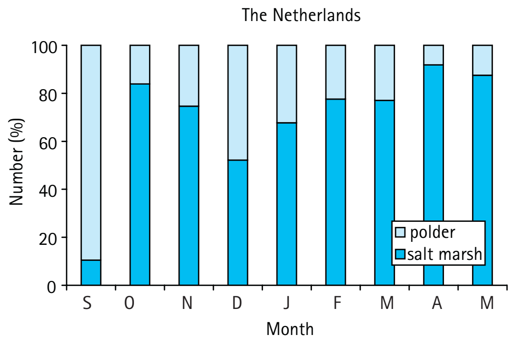
3.3 Habitat use

3.3.1 Barnacle Goose

As shown by data from Schleswig-Holstein and The Netherlands, many Barnacle Geese feed on salt marshes in the Wadden Sea (Figure 7). Here, they prefer *Puccinellia* and *Festuca*-dominated vegetation types (*e.g.* Ydenberg and Prins, 1981; Ebbinge and Boudewijn, 1984). In Schleswig-Holstein, on average 48% of the geese can be found on salt marshes. Just after arrival in September/October and in spring (especially prior to departure in May), many birds also feed on semi-natural grassland in the embanked wetlands, such as Beltringharder Koog and Rickelsbüller Koog. Feeding on fertilized grassland (especially *Lolium* and *Poa* swards) is common in autumn in the Hattstedter Marsch and in autumn, winter and spring also locally on the Eiderstedt peninsula. Feeding on crops (autumn-sown cereals) at coastal sites behind the seawall is less common but is observed in fluctuating numbers and depends on winter weather (increased crop-feeding during cold spells). In the Dutch Wadden Sea, on average 75% of all Barnacle Geese in September-May were observed on salt marshes, the remaining 25% on polders behind the seawall (Figure 7). Despite the population increase, there was only little variation in this pattern between years. However, in the course of winter, there was a tendency towards higher numbers on polders in December and January. This shift in feeding preferences coincides with the departure of large numbers of Barnacle Geese from coastal sites in the Dutch Wadden Sea to the staging sites in e.g. Friesland (Figure 2). The geese observed on polders behind the seawall mainly feed on fertilized grassland and occasionally visit fields with autumn-sown cereals. Recently, increasing numbers have been observed to exploit harvest remains of sugar beet and carrots (K. Koffijberg, in prep.). In Niedersachsen, data from the Rheiderland/Dollart area points to a similar pattern to that found in the Dutch Wadden Sea (Borbach-Jaene *et al.*, 2002; Kruckenberg, in prep.). Here, on average 22% of the Barnacle Geese feed on salt marshes between October-April, whereas 78% of all birds utilize fertilized pastures at sites behind the seawall. From 1996 to 2003, however, the grazing intensity on the salt marsh declined, and dropped from 32% to 19% of the overall number of (increasing) goose days spent in the entire area (Kruckenberg, in prep.). The background to this reduced used of salt marshes is not known, but is not related to changes in grazing management, which did not change during this period.

Compared to Dark-bellied Brent Geese, Barnacle Geese obviously favor feeding sites along the mainland coast, with short flying distances to freshwater sources for drinking (Stahl *et al.*, 2002).

Only minor numbers visit the barrier islands (Figure 8). In The Netherlands, usually 11% of the annual numbers counted are reported from the islands, mainly at Schiermonnikoog. A similar pattern is also found in other parts of the Wadden Sea. In Schleswig-Holstein as many as 99% of all Barnacle Geese are found along the mainland coast (Günther, 2005). The salt marshes and pastures at the Halligen, which are favored by Dark-bellied Brent Geese are hardly visited by Barnacle Geese.



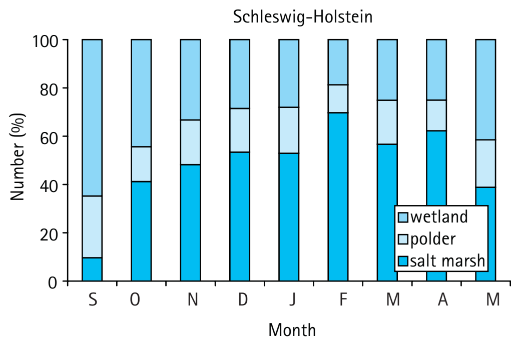


Figure 7: Distribution of Barnacle Geese over salt marshes and inland habitats (polders and embanked coastal wetlands) in The Netherlands and Schleswig-Holstein during winter, expressed in goose days spent in September-May.

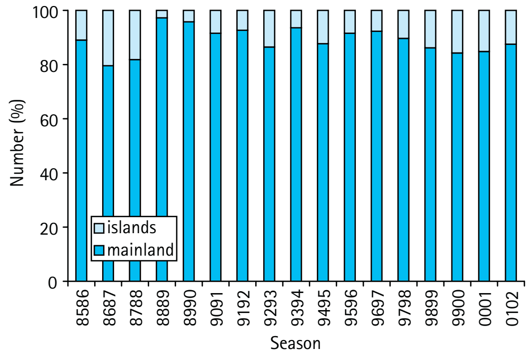


Figure 8: Changes in numbers of Barnacle Geese over feeding sites along the mainland coast and on the barrier islands in the Dutch part of the Wadden Sea, expressed as percentages of the annual number of goose days in September-May.

The overall increase in numbers has not affected the proportion of Barnacle Geese feeding on the islands in the Dutch Wadden Sea so far, although small numbers have expanded to other islands such as Ameland, Terschelling and Texel, and increasing but small numbers have been recorded from some of the islands in Niedersachsen.

3.3.2 Dark-bellied Brent Goose

Dark-bellied Brent Geese in general favor salt marshes as well. During arrival in autumn small numbers also feed in the intertidal area, but these cannot be separated in our data since counts are carried out during high tide, when aquatic feeding birds often gather at the edges of the salt marshes and where they are counted together with salt marsh-feeding birds (Koffijberg *et al.*, 2003). During autumn and winter, they also feed in large numbers in inland polders behind the seawall, as, for example, expressed by the counts in The Netherlands. Overall, on average 59% of the Dutch geese between September and May were observed in this habitat (Figure 9). There were remarkably small fluctuations in this distribution between years. High numbers of Dark-bellied Brent Geese feeding in polders are typical for the Dutch islands in winter, where the large inland polders at Schiermonnikoog, Ameland, Terschelling and Texel provide suitable agricultural areas with fertilized pastures. Along the Dutch mainland coast, where crops dominate and grassland is scarce, inland feeding is observed only occasionally on autumn-sown cereals and oil-seed rape. The shift from coastal feeding sites to inland sites in The Netherlands already starts in October. Towards November-December, most birds have left the Wadden Sea for their wintering areas in England and France. By this time, the majority of the remaining (wintering) birds in The Netherlands have switched to inland feeding sites. With the onset of spring migration, from February onwards, growing numbers are found again on the salt marshes, including the Halligen in Schleswig-Holstein (Günther, 2005). In The Netherlands, however, many Dark-bellied Brent Geese remain to feed on fertilized pastures, which in May still support 37% of the birds (Figure 9). Compared with data from the 1970s (Ebbinge and Boudewijn, 1984), inland feeding in the Dutch Wadden Sea nowadays occurs for a more prolonged period. In the 1970s,

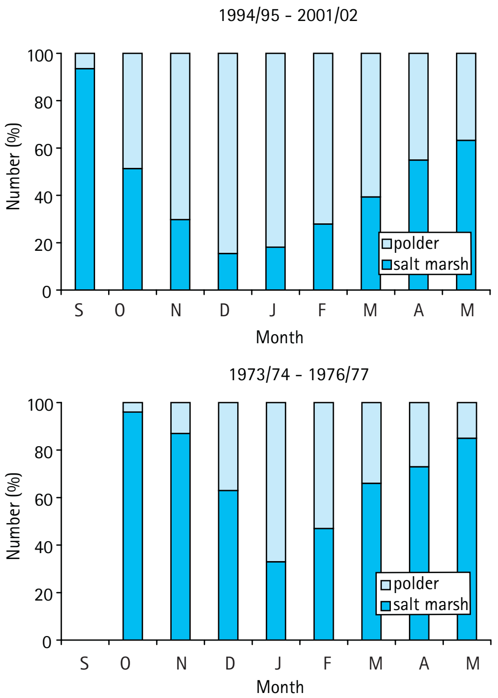


Figure 9: Distribution of Dark-bellied Brent Geese over salt marshes and inland habitats (polders) in the Dutch part of the Wadden Sea, expressed by goose days spent in September-May. Also given is the distribution over these habitats in 1974-77 (Ebbinge and Boudewijn, 1994), which show that nowadays many more Dark-bellied Brent Geese utilize the inland pastures for feeding.

only in January and February did more than 50% of the geese stayed at inland sites. Between 1994-2002 this period lasted from November to March, with high numbers remaining until departure in May (Figure 9).

Contrary to Barnacle Geese, Dark-bellied Brent Geese are especially attracted by feeding sites on the barrier islands. In the Dutch Wadden Sea, 67% of all goose days between 1985 and 2002 were spent on islands. In Schleswig-Holstein (including the Halligen) this even involved 74% of all birds (Figure 10). It is intriguing that the recent decline in numbers coincides with an increasing proportion of Dark-Bellied Brent Geese staying on islands. Especially in Schleswig-Holstein, the distribution over mainland and island-feeding changed considerably in the past decade. During 1997-2002, on average only 11% stayed along the mainland coast, compared to 44% in 1987-1991 (Figure 10; see also Günther, 2005). In The Netherlands, the proportion of birds found along the mainland coast declined from 39% to 20%. Here, numbers visiting the islands remained rather stable, whereas a sharp decrease has been observed along the mainland coast since 1994/1995.

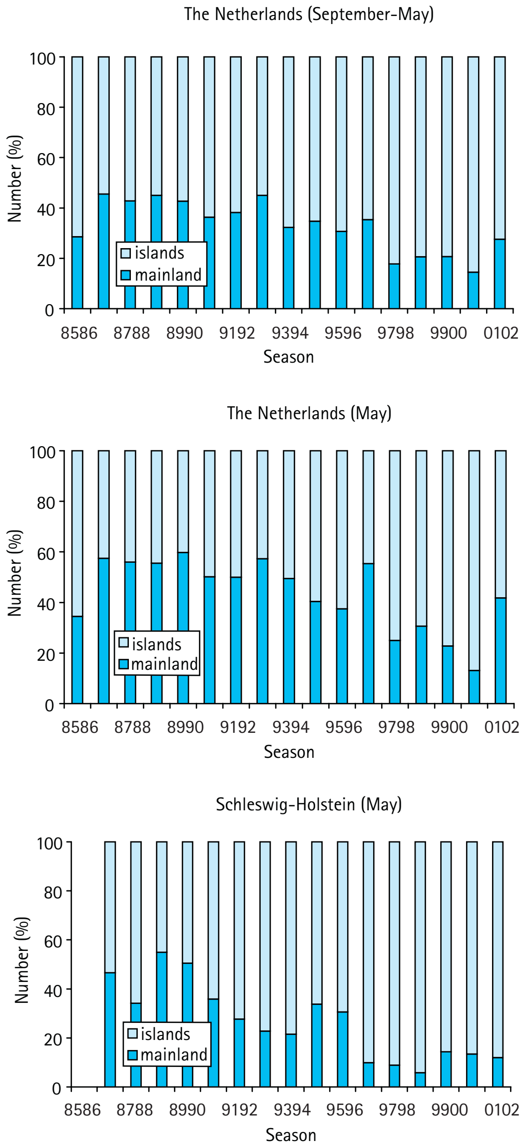


Figure 10: Changes in numbers of Dark-bellied Brent Geese over feeding sites along the mainland and on the islands in The Netherlands and Schleswig-Holstein, expressed as percentages of the annual number of goose days in September-May (NL) or May (NL and SH).

4. Discussion

4.1 Expansion of Barnacle Geese

The trilateral counts in the Wadden Sea in January 1993-2000 (including inland sites adjacent to the seawall in Niedersachsen) involved on average 60% of the total Russian-Baltic flyway population (Figure 11). During spring migration in March, the average share of the flyway population concentrating in the Wadden Sea is even higher (75%). Low numbers in January (1996 and 1997) are a result of cold spells, which often initiate a shift to inland wintering sites in The Netherlands, such as Friesland or the Delta area in the SW-Netherlands (see section Phenology). In 1996, cold weather lasted until April, and also affected the numbers present in March. Besides these cold rushes, there is a clear trend that a progressively smaller proportion of the Russian-Baltic Barnacle Goose population winters in the Wadden Sea. With the ongoing growth of the flyway population, increasing numbers of Barnacle Geese have expanded their wintering range to inland feeding areas outside the Wadden Sea, especially in The Netherlands and Niedersachsen (Figure 2). In The Netherlands, at eight out of 21 important inland staging sites for Barnacle Geese outside the Wadden Sea, the number of goose days doubled in the 1990s (van Roomen *et al.*, 2004). Increases were also reported in the western part of Niedersachsen, where Barnacle Geese show upward trends in, for example, all staging areas in Ostfriesland (Kruckenberg and Borbach-Jaene, 2003; Borbach-Jaene *et al.*, 2002). In Denmark, increasing numbers of Barnacle Geese are counted along the west coast, north of the Wadden Sea (Amstrup *et al.*, 2004). Apparently, the strong population increase has forced many geese to explore new feeding sites. Parallel to the increased numbers, Barnacle Geese have also prolonged their stay in the Wadden Sea in spring. Data from counts in May indicates that recently up to 115,000 Barnacle Geese are present in the Wadden Sea in the first half of this month (see Chapter 7 in Blew *et al.*, 2005, this volume).

The overall increase of Barnacle Geese in the Wadden Sea is mainly the result of the increased population size and a westward expansion of the breeding areas. In the 1970s and 1980s, these were confined to the islands Novaya Zemlya and Vaygach in the Russian arctic (Ganter *et al.*, 1999).

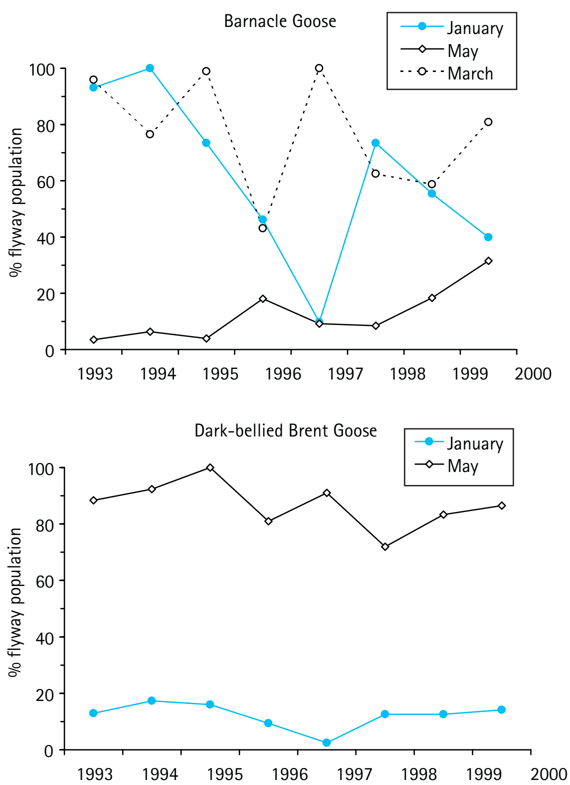


Figure 11: Numbers of Barnacle Geese and Dark-bellied Brent Geese expressed as a percentage of the Russian-Baltic and West-Siberian flyway populations respectively. Population sizes were extracted from Wetlands International (goose database) and Günther (2005).

In the 1980s, a rapid increase was reported from the Baltic (Larsson *et al.* 1988), and growing numbers of Barnacle Geese started to breed along the Russian Barents Sea coast, as far west as the Kola Peninsula (Ganter *et al.*, 1999). Although the breeding population in the Baltic area increased to 17,000 individuals in 1997 (Larsson and van der Jeugd, 1998), they still comprise a minority (6%) of the entire Russian-Baltic flyway population. Therefore, we assume that the majority of the birds in the Wadden Sea will be of Russian origin. Prior to departure in May, nearly all Barnacle Geese in the Wadden Sea will probably involve Russian breeders, since numbers present by that time include 30% of the flyway population (Figure 11). Sightings of color-ringed birds confirm this assumption (Günther, 2005). We hypothesize that the delay in spring departure is mainly caused by an alternative migration strategy of these birds. Instead of stopping-over at traditional spring staging sites in the Baltic, they are probably able to reach the western edge of their arctic breeding area in one direct flight from the Wadden Sea (similar to Dark-bellied Brent Geese flying from the Wadden Sea to the stop-over site in the White Sea, which is about the same distance Barnacle Geese have to cover; Green *et al.*, 2002). Spring staging in the Wadden Sea has therefore become increasingly important for these birds, since they will accumulate body reserves for breeding mainly here, and not at stop-over sites in the Baltic. To what extent an increase in breeding birds in the Baltic (which might compete with migrants stopping-over) is part of this re-distribution process remains unknown.

4.2 Declining numbers of Dark-bellied Brent Geese

Contrary to the upward trend in Barnacle Geese, the West-Siberian flyway population of Dark-bellied Brent Geese has experienced a considerable decline since 1996 (Ebbinge *et al.*, 2002). As a result, numbers in the Wadden Sea are much smaller now compared to the 1990s, especially during the annual peak of spring migration. Despite the reduction in overall population size, the proportion of geese utilizing the Wadden Sea has hardly changed. In January, usually 10% of the population winters in the Wadden Sea (Figure 11), mainly at sites in The Netherlands. Peak numbers during spring migration in May involved on average 85% of the flyway population between 1993-2000. Phenology changed a little during the past decade. Throughout the Wadden Sea, there has been a tendency for an earlier onset of spring migration recently, starting as early as in February and peaking from the beginning of April onwards. The background for this process is unknown. Since Barnacle Geese also show an earlier accumulation of spring numbers in the northern part of the Wadden Sea (Denmark, Figure 3), this trend might be a result of an increased tendency for mild winters, which might affect vegetation growth in the northern parts of the Wadden Sea and thus expand feeding opportunities in early spring.

The main explanation for the overall decline in numbers of Dark-bellied Brent Geese is the increased number of years in which the birds fail to raise offspring (Ebbinge *et al.*, 2002). As a result, annual mortality exceeds reproductive output and has reduced population size in the past decade. The factors which have contributed to the reduced breeding success are not clear yet. Ebbinge (2003) suggested the conditions in the Siberian breeding area as the main reason, expressed, for example, by less pronounced lemming-cycles (which regulate predation pressure by Polar Foxes *Alopex lagopus, for example*, on goose nests) and a more constant moderate to high predation pressure. According to Ebbinge (2003), condition during spring migration, as assessed annually by cannon-net catches in the Dutch Wadden Sea, has not changed during the past decade. This would imply that the opportunities to accumulate body reserves, which have shown to be an important prerequisite for successful breeding (Ebbinge and Spaans, 1995) have not changed in the Wadden Sea. However, this data only refers to a few sites and does not necessarily exclude factors in the Wadden Sea (or in the wintering areas) being responsible for recent changes in survival and/or reproduction rates. Günther (2005) has also pointed to the possible impact of the cold spring in 1996, which marks the start of the population decline. During this spring season, cold weather and a prolonged dry period in March and April prevented the vegetation in the salt marshes from developing. As a result, feeding opportunities for the geese were poor, and this might have caused higher mortality of adult birds during spring migration and during the breeding season. Surprisingly, however, it did not affect the reproductive output in the breeding areas, as in autumn 1996 many birds did return with offspring. Therefore, this hypothesis remains speculative, but it deserves further investigation as to whether changes in the wintering areas, or in the Wadden Sea, play a part in the process of the population decline of Dark-bellied Brent Geese.

4.3 Increased competition?

Since the downward trend for Dark-bellied Brent Geese coincided with a strong increase and prolonged spring staging for Barnacle Geese, competition between both species has also been put forward as a cause for the population decline in Dark-bellied Brent Geese (Engelmoer *et al.,* 2001). Especially at feeding sites along the mainland coast, both species often share the same food resources and often occur in mixed flocks on salt marshes. Behavioral studies in the Leybucht area in Niedersachsen showed that the larger-sized Barnacle Geese are clearly dominant over Dark-bellied Brent Geese in direct conflicts (Rothgänger, 2001). In the Leybucht area as well as at the Hamburger Hallig in Schleswig-Holstein, it has been observed that Dark-bellied Brent Geese changed their feeding sites as soon as Barnacle Geese had left the area (Stock and Hofeditz, 2000; Rothgänger, 2001; Weigt *et al.*, 2002). Such changes might point to competition, but could also reflect a facilitative effect, *i.e.* previous grazing by Barnacle Geese improves feeding opportunities for Dark-bellied Brent Geese (Stock and Hofeditz, 2000; Rothgänger, 2001; Stahl, 2001). In addition, declines in numbers of Dark-bellied Brent Geese have been found in areas with and without grazing of Barnacle Geese. If competition between both species occurs, it probably mainly operates at a local site-level, but does not account for the overall population decline in Dark-bellied Brent Geese. Bos and Stahl (2003) came to similar conclusions in a study covering the spring distribution of both species in the Wadden Sea. With the reduced population size and an increased proportion of Dark-bellied Brent Geese feeding at the barrier islands and the Halligen (where Barnacle Geese are often scarce or absent, see section on mainland and islands below), further competition between the two species will probably remain at a local scale. Regarding the continuous expansion of feeding areas by Barnacle Geese, however, further studies should be initiated to assess the interactions between both species and to reveal possible facilitative processes affecting food availability. This also applies to stop-over sites along the Barents Sea coast, where migrating Dark-bellied Brent Geese may compete with breeding Barnacle Geese (Ebbinge, 2004).

4.4 Feeding on salt marshes and at agricultural sites

A large proportion of Barnacle Geese and Dark-bellied Brent Geese preferably feed on the salt marshes (Figure 7, 9). However, feeding habits change during winter and differ within the Wadden Sea. Data from Schleswig-Holstein shows that many Barnacle Geese also use the embanked wetland areas to feed, especially after arrival in autumn and before departure in May. Moreover, both in Schleswig-Holstein and The Netherlands, Barnacle Geese can be found at agricultural feeding sites behind the seawall, where they feed on fertilized pastures and crops. Extensive inland feeding has also been observed in coastal areas in Niedersachsen and Denmark. Dark-bellied Brent Geese show a similar pattern, but exploit a wider range of habitats as they also feed on the intertidal flats.

For both species, it has been suggested that the shift between salt marsh and inland agricultural feeding sites is triggered by the difference in food quality and quantity, which is low on salt marshes during late autumn, winter and early spring, but increases gradually in the course of spring (Boudewijn, 1984; Prins and Ydenberg, 1985; Vickery *et al*., 1995; Bos and Stahl, 2003). This explains why large numbers of geese mainly feed at coastal agricultural sites from November till March or move to agricultural feeding areas further inland (Figure 2, 7, 9). The fluctuations in the observed numbers of Barnacle Geese in the Wadden Sea in March are probably a result of between-year differences in the onset of vegetation growth in the salt marshes. As well as differences in food availability, there is also evidence that higher disturbance levels at agricultural sites prevent the geese from adopting an efficient foraging strategy and force birds to move to the less disturbed salt marshes (Prins and Ydenberg, 1985). This was confirmed in an 'accidental' experiment at Schiermonnikoog, which showed that a ban on scaring activities by farmers (as part of a special goose management scheme) attracted larger numbers of geese to the agricultural area and initiated a prolonged stay of the geese towards spring (Bos and Stahl, 2003).

In addition, the use of salt marshes will also be affected by overall population numbers and adopted traditions in use of feeding sites. Ebbinge (1992) showed that feeding on polders by Dark-bellied Brent Geese became increasingly important in the 1970s and 1980s, when the flyway population started to grow and the traditional feeding sites on the salt marshes became saturated. The expansion of the feeding range of Barnacle Geese described in this chapter, and the exploitation of new food resources such as harvest remains, which has been observed recently for this species, are probably part of a similar process. The fact that, despite the population decline since 1996, Dark-bellied Brent Geese continue to visit agricultural sites in high numbers (at least in The Netherlands; Figure 9) show, however, that the birds are also very well able to maintain changed traditions.

4.5 Feeding on mainland versus islands

One of the most striking differences in the feeding habits of Barnacle Geese and Dark-bellied Brent Geese in the Wadden Sea is the distribution over the barrier islands/Halligen and the mainland coast. Dark-bellied Brent Geese are found in much larger numbers at the islands and Halligen, whereas Barnacle Geese concentrate along the mainland coast (Figure 8, 10). As shown by Stahl *et al.* (2002), Barnacle Geese are physiologically constrained in their choice of feeding sites in saline habitats like the Wadden Sea. They prefer the less inundated sites with a higher elevation and avoid vegetation with a high salt load, unless fresh water for drinking is available nearby. Dark-bellied Brent Geese are adapted to cope with saline conditions, and are, for example, able to feed on green algae on the intertidal mudflats or at the lower fringes of the salt marshes which are inundated regularly. It is striking that both in Schleswig-Holstein and in The Netherlands, the recent decline in Dark-bellied Brent Goose numbers has caused a change in distribution over the mainland coast and the islands. Following the reduction in overall numbers, an increased proportion of the geese have contracted their feeding range to the islands (Figure 10).

In Schleswig-Holstein, the current distribution of Dark-bellied Brent Geese over mainland and island feeding sites resembles the situation in 1977-79, when about 75% of the geese were found on the islands and 25% staged along the mainland coast (Prokosch, 1991). By that time, the overall population size was only slightly smaller than it is now.

This process of re-distribution probably reflects the same kind of density-dependent regulation that was described by Ebbinge (1992) for the utilization of salt marshes and fertilized grassland behind the seawall (see previous section). During the period in which Dark-bellied Brent Geese showed a strong upward trend (until 1995), a marked expansion of feeding sites was reported on the salt marshes along the mainland coast (*e.g.* Engelmoer *et al.*, 2001), which might indicate that 'preferred' feeding sites at the barrier islands became saturated. According to this hypothesis, the current decline leads to a 'retreat' to the favored feeding sites on the islands. To what extent other factors contribute to this development has to be clarified. As mentioned before, competition with the increased population of Barnacle Geese at mainland staging sites might occur, but probably only at local site level. Furthermore, the sharp decline of numbers of Dark-bellied Brent Geese along the mainland coast in Schleswig-Holstein (when compared to The Netherlands) might also be accelerated by the abandoned livestock grazing in the 1990s, which has occurred on a much smaller scale in The Netherlands.

5. Conclusions / Implications for Management

Data from the trilateral goose counts in the Wadden Sea shows that the population of Barnacle Geese and Dark-bellied Brent Geese in the past decade have experienced some major changes:

Barnacle Geese

- Due to the increase of the Baltic-Russian flyway population, the numbers and feeding range in the Wadden Sea have expanded considerably in the past decades, especially in spring and mainly along the mainland coast and at sites outside the Wadden Sea;
- In the 1990s, up to 85% of the flyway population concentrated in the Wadden Sea (March), however, the Wadden Sea has become less important for wintering birds, since largest numbers in winter are found outside the Wadden Sea, in The Netherlands;
- Along with the increase in numbers and feeding sites, Barnacle Geese have prolonged their stay in spring by four to six weeks and leave the area around mid-May. Recent counts show that up to 30% of the flyway population (mainly assumed Russian breeders) is still present in the Wadden Sea in the first half of May;
- As a result of the delayed spring departure, the Wadden Sea has become increasingly important for Russian Barnacle Geese in particular to accumulate body reserves for breeding.

Dark-bellied Brent Goose

- Lower reproduction rates have initiated a decline in the West-Siberian population of Dark-bellied Brent Geese around 1995. As a result, lower numbers are found in the Wadden Sea;
- Despite the downward trend, the spring staging sites in the Wadden Sea still support about 85% of the flyway population, whereas in winter only a minor share of the flyway population (10%) winters in the area;
- Following the population decline in the Wadden Sea, an increased proportion of the geese are found at the barrier islands and Halligen, especially in the core staging areas in The Netherlands and Schleswig-Holstein.

For both Barnacle Geese and Dark-bellied Brent Geese, the overall changes which have occurred in numbers, distribution and habitat utilization in the Wadden Sea are mainly related to changes at population level of both species. So far, no evidence has been found that management changes and changes in feeding and staging conditions for the geese in the Wadden Sea have contributed to the decline and increase in Dark-bellied Brent Goose and Barnacle Goose respectively (but see re-distribution of Dark-bellied Brent Geese, below). Feeding opportunities for geese have experienced changes in the Wadden Sea in the 1990s with the abandonment of livestock grazing in large parts of the mainland salt marshes of Schleswig-Holstein and Niedersachsen. Several studies have shown that livestock grazing increases the feeding opportunities for geese. Bos *et al.* (in prep.) analyzed vegetation types and the spring distribution of Dark-bellied Brent Geese in the Wadden Sea, and concluded that a situation in which all salt marshes were livestock-grazed, the number of geese supported could be four times higher than in a situation with no livestock grazing at all. Furthermore, they showed that many suitable sites were used less than expected from their vegetation composition, thus being available as alternative or additional feeding sites when conditions elsewhere deteriorated. Similar findings have been produced from a monitoring program in Schleswig-Holstein, which investigated changes in vegetation after the abandonment of livestock grazing and the response of geese to the changed management. Although the geese re-distributed themselves over the area, the maximum numbers and duration of staging did not differ before and after the management changes (Stock and Hofeditz, 2000; 2002). The sharp decrease in numbers of Dark-bellied Brent Geese along the mainland coast of Schleswig-Holstein, and the earlier arrival of large numbers of Barnacle Geese in the Dutch Wadden Sea (see sections Phenology – Barnacle Goose, Feeding on mainland versus islands), however, might also be considered a similar re-distribution process. Here, analysis of movements by sightings of color-marked birds could underpin further evidence.

It will be difficult to predict how the flyway population of Barnacle Geese and Dark-bellied Brent Geese will develop in the years to come. Although the reproductive output of Barnacle Geese seems to have leveled off in recent years (Sovon Ganzen- en Zwanenwerkgroep, 2001; Günther, 2005), the population has continued to increase since 2000. For Dark-bellied Brent Geese, signs of a population recovery have not yet become visible. If the numbers of Barnacle Geese continue to rise, we assume a further expansion of feeding areas in the Wadden Sea (especially in spring) and its immediate surroundings, *i.e.* agricultural areas along the mainland coast (especially in autumn and winter), and to a lesser extent probably also the polders at the islands. However, the largest increases will probably be noted at sites outside the Wadden Sea (Figure 2). Here, potential conflicts with farmers will increase. Also, as shown earlier in discussions about management of the salt marshes in the Leybucht area in Niedersachsen (Bergmann and Borbach-Jaene, 2001; Lutz *et al.*, 2003) debate will arise as to whether the geese should be accommodated in the Wadden Sea and the salt marshes should be managed in such a way that they can support maximum numbers of geese. Concerning the high number of Barnacle Geese, and the low food quality and quantity at salt marshes in autumn and winter (when compared to fertilized grassland), such a management scenario would not be very successful, since the higher profitability of feeding on fertilized pastures in autumn and winter will always attract large goose numbers. Moreover, the trilateral targets concerning salt marsh management do not include such a species-specific management (de Jong *et al.*, 1999). These aim at natural salt marshes, as well as providing favorable conditions for all migratory and breeding bird species, including species such as Redshank, which prefer tall vegetation for breeding. These targets are in line with the European Habitat Directive, which does not include specific management policies for species-groups such as geese (Lutz *et al.*, 2003).

Moreover, since Barnacle and Dark-bellied Brent Geese depend on the Wadden Sea for only a part of their annual life-cycle, goose management should preferably be achieved at flyway level, with inclusion of all countries within the flyway. Only in this way can a proper management and monitoring of populations and a prevention of actions which would lead to a bottleneck-situation in the Wadden Sea be achieved. Such a flyway management plan has been put forward recently for Dark-bellied Brent Geese by the African Eurasian Waterbird Agreement (AEWA) (van Nugteren, 1997), but this plan had not yet been endorsed by the governments involved.

Solutions for the co-existence of farmers and geese should be found preferably through agri-environmental management schemes in the agricultural feeding areas of the geese. Currently, several of such schemes are running in all Wadden Sea countries (Laursen, 2002). They include management of special reserves (*e.g.* Zeeburg on Texel), agri-environmental schemes (*e.g.* in The Netherlands, Niedersachsen and Schleswig-Holstein), compensation payment for damage (The Netherlands, earlier in Schleswig-Holstein) and active scaring management (The Netherlands, Denmark). In Schleswig-Holstein, there is also an open season for shooting Barnacle Geese at inland sites along the Wadden Sea coast on arable fields, in case damage to crops occurs. As shown by Bos and Stahl (2003), agri-environmental schemes which include a ban on scaring and limit disturbance can be successful to accommodate many extra geese, although similar studies on the Dutch mainland have shown that not all staging areas are suitable to receive 'extra' geese that are actively scared away from surrounding areas (Ebbinge *et al.*, 2000; van Roomen *et al.*, 2004). Designation of staging sites where such schemes should operate must be chosen carefully according to the expected capacity to accommodate extra geese and experiences with grazing damage in the past. As shown by the 'agri-goose' schemes in The Netherlands, farmers tended to accept a higher level of grazing damage and at some sites they started to initiate information centers to increase public awareness of the Nordic geese staying on their fields (Ebbinge *et al.,* 2003).

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WADDEN SEA ECOSYSTEM No. 20

Curlews in the Wadden Sea – Effects of Shooting Protection in Denmark

Karsten Laursen

2005
Common Wadden Sea Secretariat
Trilateral Monitoring and Assessment Group
Joint Monitoring Group of Migratory Birds in the Wadden Sea

Contents

Curlew
(Photo: Eigil Ødegaard).

Summaries

Summary

The Curlew was a quarry species in Denmark up to 1994. An evaluation of Curlew numbers 1980-2000 in relation to both protection measures in Denmark and management of the Danish Wadden Sea was conducted. Four steps towards a protection of Curlews in Denmark took place: a) 1982, August was excluded from the open season for Curlew; b) 1992, the departmental order of the 'Wildlife Reserve Wadden Sea' was revised, which closed large areas from shooting; c) 1994, the Curlew became totally protected in Denmark; d) 1998, shooting waterbirds in the Danish Wadden Sea was stopped. The study examined whether there is a relationship between the hunting pressure in Denmark and the number of wintering Curlews in the International Wadden Sea. A population model was designed taking into account the parameters "protection measures in Denmark", "hunting bag", "juvenile ratios in the hunting bag", "weather" and "monitoring results".

The number of Curlews in the Wadden Sea during winter increased from about 160,000 to more than 250,000 individuals in 1995, then the number stabilized at about 200,000 (Blew *et al.*, 2005). It is concluded that the general increase of numbers of Curlews in the International Wadden Sea could be explained by the hunting protection of the species in 1982 and in 1994 in Denmark. The assumption that hunting mortality could be an additive to other mortality causes is supported by the population model presented, in which the hunting mortality of Curlews in Denmark was added to the general mortality in the years after hunting was reduced or stopped. The largest effect of the survival was the reduction of the open season for Curlew by one month from 1982 and onwards. This gave an additional yearly survival of 1.7% for the adults and 15.5% for juveniles. For comparison, the total ban of Curlews in Denmark in 1994 raised the yearly survival of adults by 0.15% and for juveniles by 2.1%. Closing large areas for shooting in the Danish Wadden Sea in 1992 and a total ban on shooting in 1998 also affected the geographical distribution of Curlews, *e.g.* the numbers increased in the Danish Wadden Sea during autumn by a factor of 3-4 during the following years. This increase was far above the reproductive capacity of the species.

Sammenfatning

Stor regnspove var jagtbar i Danmark op til 1994. I denne rapport vurderes antallet af Stor regnspove i 1980-2000 i forhold til både artens fredning i Danmark og forvaltningen af det Dansk Vadehav. Stor regnspove blev omfattet af en stigende beskyttelse i fire omgange: a) I 1982 blev jagttidens start udskudt en måned til 1. september, b) bekendtgørelsen for 'Vadehavet Vildtreservat' blev revideret og store områder blev lukket for jagt, c) i 1994 blev arten total fredet i Danmark, og d) i 1998 blev jagt på vandfugle standset i Vadehavet (med undtagelse af nogle forlandsarealer). For at analyserer udviklingen i antallet af Store regnspover er der udviklet en model, som inddrager oplysninger om 'beskyttelsesstatus i Danmark', 'jagttudbytte', 'andelen af ungfugle i jagtudbyttet', 'vejrforhold' og 'optællingsresultat'.

Antallet af Store regnspover i Vadehavet steg om vinteren fra 160.000 til mere end 250.000 individer i 1995, hvorefter antallet stabiliseredes omkring 200.000 (Blew *et al.* 2005). Det konkluderes at den generelle stigning i antallet af Stor regnspove i det internationale Vadehav kan forklares ud fra fredning af arten i 1992 og i 1994 i Danmark. Formodningen om at den dødelighed som var forårsaget af jagt kunne være additiv i forhold til andre dødsårsager støttes af den foreslåede bestandsmodel, hvor dødeligheden forårsaget af jagt på Stor regnspove i Danmark blev lagt til den almindelige dødelighed i årene efter at jagten var reduceret eller standset. Den største effekt på forøget overlevelse var udskydelse af jagttidens start med en måned fra 1982. Det medførte en stigning ioverlevelsen på 1,7% for gamle fugle og 15,5% for ungerne. Til sammenligning øgede totalfredningen i 1994 de gamle fugles overlevelse med 0,15% og de unge fugles med 2,1%. Lukning af store områder for jagt i det danske Vadehav i 1992 og et næsten totalt jagtforbud i 1998 påvirkede artens geografiske fordeling, f.eks. blev antallet forøget i det danske Vadehav om efteråret med en faktor 3-4 i de følgende år. En årlig stigning af denne størrelsesorden er langt over artens naturlige reproduktion, og må derfor skyldes lokale forskydninger.

Zusammenfassung

Der Brachvogel hatte in Dänemark eine Jagdzeit bis 1994. Für den Zeitraum 1980-2000 wurde die Bestandsgröße der Brachvögel sowohl in Bezug auf Schutzmaßnahmen in Dänemark als auch in Bezug auf das Management des dänischen Wattenmeeres ausgewertet. Der Schutz des Brachvogels wurde in Dänemark in vier Schritten vollzogen: a) 1982 wurde der August von der Jagdzeit ausgenommen, b) 1992 wurde die Verordnung für das "Wildschutzgebiet Wattenmeer" geändert und große Gebiete für die Jagd geschlossen, c) 1994 wurde der Brachvogel in Dänemark vollständig geschützt, d) 1998 wurde die Wasservogeljagd im dänischen Wattenmeer gänzlich eingestellt. In der Studie wurde untersucht, ob zwischen dem Jagddruck in Dänemark und der Anzahl überwinternder Brachvögel im internationalen Wattenmeergebiet eine Beziehung besteht. Es wurde ein Populationsmodell entwickelt, das die Parameter "Schutzmaßnahmen in Dänemark", „Jagdstrecke", "Jungvogel-Anteil an der Jagdstrecke", "Wetter" und "Monitoring-Ergebnisse" berücksichtigt.

Die Anzahl der Brachvögel im Wattenmeer nahm bis 1995 von etwa 160.000 auf mehr als 250.000 zu, dann stabilisiert sich die Zahl auf etwa 200.000 Individuen (Blew *et al.*, 2005). Es wird gefolgert, dass die allgemeine Zunahme der Brachvogelzahlen im internationalen Wattenmeer mit dem Schutz der Art vor jagdlicher Nachstellung 1982 und 1994 in Dänemark erklärt werden könnte. Die Annahme, dass jagdliche Mortalität additiv zu anderen Mortalitätsgründen sein könnte, wird durch das Populationsmodell unterstützt, da in den Jahren nach Reduktion bzw. Aufgabe der Jagd der allgemeinen Mortalität die Mortalität durch Jagd in Dänemark hinzugefügt wurde. Den größten Effekt auf die Überlebensrate der Brachvögel hatte die Reduktion der Jagdzeit um einen Monat ab 1982. Dadurch stieg die Überlebensrate der Adulten um 1,7% und die der Juvenilen um 15,5%. Dagegen erhöhte das totale Jagdverbot auf Brachvögel in Dänemark 1994 die jährliche Überlebensrate der Adulten nur um 0,15% und die der Juvenilen um 2,1%. Die großflächige Einstellung der Jagd im dänischen Wattenmeer 1992 und das totale Jagdverbot 1998 beeinflussten auch die geographische Verteilung der Brachvögel, so nahmen z.B. die Zahlen im dänischen Wattenmeer im Herbst während der folgenden Jahre um den Faktor 3-4 zu. Dieser Anstieg lag weit über der Fortpflanzungskapazität der Art.

Samenvatting

Tot 1994 was de Wulp in de Deense Waddenzee een bejaagbare vogelsoort. Om het effect van de veranderingen in de jacht en beheer in de Deense Waddenzee te onderzoeken werd een analyse van trends van Wulpen in de periode 1980-2000 uitgevoerd. Bescherming van Wulpen vond plaats in vier fasen: (1) 1982 - het uitsluiten van augustus in het jachtseizoen; (2) 1992 – het reglement van het ‚Wildlife Reserve Wadden Sea' werd gewijzigd en diverse gebieden werden gesloten voor jacht; (3) 1994 – volledige bescherming van Wulpen en (4) 1998 – verbod op jacht op alle watervogels. Doel van de analyse was om na te gaan of er een verband bestaat tussen de afgenomen jachtdruk in Denemarken en de aantallen overwinterende Wulpen in de internationale Waddenzee. Hiertoe werd een model opgesteld, met als parameters ‚bescherming in Denemarken', ‚aantal geschoten vogels', ‚aandeel eerstejaars onder de geschoten vogels', ‚weersomstandigheden' en ‚telresultaten'.

Het aantal overwinterende Wulpen in de internationale Waddenzee groeide van ongeveer 160.000 individuen tot meer dan 250.000 vogels in 1995. Vervolgens stabiliseerde dit aantal zich tot rond de 200.000 (Blew *et al.*, 2005). Er zijn sterke aanwijzingen gevonden dat deze toename wordt ingegeven door de beschermende maatregelen in Denemarken in 1982 en 1994. Dit wordt bevestigd door de modelberekeningen, die er op wijzen dat door het wegvallen van de additionele sterfte als gevolg van de jacht in Denemarken, het aantal Wulpen kon toenemen. Het grootste effect op de overleving was het uitsluiten van augustus in het jachtseizoen in 1982. Dit leverde voor volwassen Wulpen een jaarlijkse verhoging van de overleving op van 1.7%; voor eerstejaars 15.5%. Ter vergelijking: na het volledig verbod van de jacht op Wulpen nam de overleving voor volwassen vogels toe met 0.15%, voor eerstejaars met 2.1%. Door het sluiten van gebieden voor de jacht in 1992 en het totale verbod op watervogeljacht in 1998 veranderde ook de verspreiding van Wulpen in de internationale Wadden Zee. De toename met een factor 3-4 die optrad is veel hoger dan uit reproductie alleen verklaard kan worden.

1. Introduction

The Curlew (*Numenius arquata*) has been protected from shooting in Germany and The Netherlands for a long time, but it was a quarry species in Denmark up to 1994. Most wader species had been hunted in Denmark in the past. These species are numerous and widespread over most of the country, which has a coastline of almost 7,000 km bordered by shallow water and large salt marshes. Ten wader bird species (Oystercatcher, Golden Plover, Grey Plover, Lapwing, Knot, Black-tailed Godwit, Bar-tailed Godwit, Redshank, Spotted Redshank and Greenshank) were protected from shooting in 1983. However, until the end of 1993 it was still allowed to shoot Curlews, which was a popular quarry species among Danish hunters. The species is rather easy to hunt by imitating its characteristic call and using a camouflage net and decoys. The aim of this report is to evaluate the effects of the national protection measures in Denmark and the management of the Danish Wadden Sea on Curlew numbers both in the Danish and the International Wadden Sea.

1.1 Protection measures in Denmark and the Danish Wadden Sea

The protection of Curlews in Denmark and in the Danish Wadden Sea took place over several years, and included five steps. 1) In 1979, the 'Wildlife Reserve Danish Wadden Sea' was established by a departmental order with the aim to protect waterbirds from shooting and other human disturbance. 2) In 1981 and 1982, the open season for Curlew was shortened in Denmark by a month by postponing the open season from 1 August to 1 September. 3) In 1992, the departmental order of the 'Wildlife Reserve Wadden Sea' was revised, which closed large areas from shooting. 4) In 1994, the Curlew became totally protected in Denmark and 5) in 1998, shooting waterbirds in the Danish Wadden Sea was stopped in most of the area.

1.2 Game statistics

Since 1941, Danish hunters have reported their annual bag, and according to game statistics an average of more than 40,000 Curlews were yearly shot during 1950-1970. In this estimate the Whimbrel is also included due to pooling of the two species in the game statistics. However, the numbers of Whimbrel constituted only about 2% of the total bag (Clausager, pers. comm.). In the 1970s, the number of Curlews shot began to decrease year by year until the beginning of the 1980s (Figure 1) (Strandgård and Asferg, 1980). The decreasing number of Curlews shot started a debate between hunters and conservationists about protecting the species. Wing surveys from 1979-1989 showed that in August the proportion of adult birds was larger than later on during autumn (Clausager, pers comm.). The reason is that the adult Curlews arrive earlier in the Wadden Sea than the juvenile birds. From a population dynamic aspect adult birds are more valuable than juvenile birds, because they are more experienced and their survival rate is higher than that of the juveniles (see below). Therefore, to protect adult birds from shooting the open season for Curlew was postponed by one month over two years from 1 August to 1 September (from 1 August in 1980 to 16 August in 1981 and to 1 September in 1982). From 1982, and the following years the bag of Curlews was 8,000-10,000 birds shot per year. In 1993, the bag was about half the size of that in the 1980s (Figure 1).

The bag of Curlew was analyzed for the Danish Wadden Sea area in the years 1979/1980 and 1980/1981 by questionnaires send out to about 20% of the hunters (Laursen, 1985). The results showed that the majority of Curlews were shot along the mainland coast, on salt marshes and in fields behind the seawalls. The bag in the two seasons in the Danish Wadden Sea area was 9,500 and 10,600 Curlews, which made up about 39% of the total bag of the species in Denmark. These estimates indicate that a considerable number of Curlews shot in Denmark were from the Danish Wadden Sea region. However, some 60% were shot elsewhere in the country.

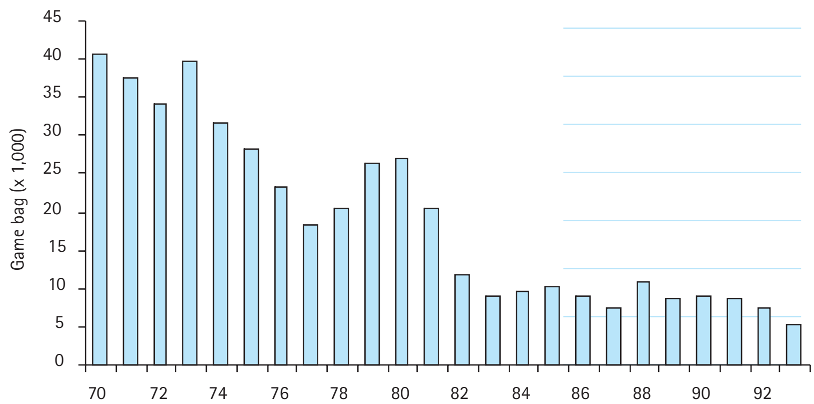

Figure 1: Annual game bag of Curlew in Denmark 1970–1993. Data from the official game statistics. The bag of Whimbrel is also included, but is only 2% of the total bag (see text).

2. Material and Methods

Counts of Curlews in the International Wadden Sea and in the Danish Wadden Sea are part of the Trilateral Monitoring and Assessment Program (TMAP), and previous co-ordinated counts have been performed since 1980 (Meltofte *et al.*, 1994). Trilateral counts from 1992-2000 are presented in Blew *et al.* (2005, this volume, see chapter 4.26). The results of these counts are used in this report and they are a combination of actual numbers counted plus numbers estimated, due to sites not covered. However, in this report the figures are refereed as number counted.

To evaluate the effect of protection of Curlew the trilateral data was supplemented by data from national monitoring programs. Two independent data sets from the Danish Wadden Sea were used for this study. 1) Trilateral co-ordinated counts at midwinter 1980-2000, in which data from both ground and aerial counts was combined. However, the data was dominated by ground counts. The midwinter counts in Denmark have been performed every year except in 1994. 2) Counts from aircraft in autumn 1980-2000, during the peak staging period of Curlews (August-November), in total 81 counts were performed. Counting Curlews from aircraft has been evaluated in relation to ground counts in the same sites. The results showed a significant correlation between the number counted from the ground and from aircraft in the same sites. However, the number recorded from aircraft was smaller than those from the ground (Laursen and Frikke, in prep.). Therefore only indices for the actual number of birds have been used in this report.

An annual index value and the trend over years were calculated using the method described by Delany *et al.* (1999). The population index for year 19xx thus equals: Population size in 19xx/population size in the base year.

In this report the term 'International Wadden Sea' refers to the total area of the Wadden Sea shared by The Netherlands, Germany and Denmark, and the term 'Danish Wadden Sea' refers to the Danish part of the Wadden Sea.

Table 1: Trend (yearly increase) of the number of Curlews counted by ground counts in Great Britain, the International Wadden Sea and the Danish Wadden Sea 1980-2000, together with a model for Curlews in the International Wadden Sea 1983-2000. Counts from aircrafts. Correlation coefficient (Partial R, accounting for annual trend) and statistical significance for a Pearson correlation analysis is given together with degrees of freedom (DF). * P < 0.05, ** P < 0.001, *** P < 0.001, **** P < 0.0001.

Region and Season	Trend	Partial R		DF
Great Britain, midwinter	0.0172	0,554	****	19
International Wadden Sea, midwinter	0.0298	0.253	**	19
Danish Wadden Sea, midwinter	0.0244	0.602	****	19
Danish Wadden Sea, autumn	0.1467	0.434	***	19
Model, midwinter	0.0796	0.7865	****	17

2.1 Preconditions

Two assumptions are analyzed before the hypothesis can be examined. These are 1) that the Curlew population using the International Wadden Sea forms a unity of the breeding population in Northwest Europe, and that this unity is faithful to its wintering range, *e.g.* that Curlews using the International Wadden Sea only mix to a small extent with the Curlews wintering in Great Britain. 2) To examine if there is a relationship between the Curlew number shot in Denmark and the number of wintering Curlews in the International Wadden Sea.

2.1.1 Curlews in the Wadden Sea and Great Britain

The majority of Curlews breeding in Northwest Europe winters in the Wadden Sea and the British Isles (Meltofte *et al.*, 1993). An examination was made as to whether these birds make up one unit, or if it is more likely that they are separate groups of the same flyway population. The question was analyzed by comparing the rate of yearly increase in Great Britain for 1980-2000 and the numbers in the International Wadden Sea. The yearly increase in Great Britain was 1.7%, whereas in the International Wadden Sea it was 3% (Table 1). This nearly two-fold difference in the yearly increase recorded in the two areas indicates that two subunits of the Curlew flyway population use them. However, in the counts from both Great Britain and the International Wadden Sea the number of Curlew seems to have reached a maximum number in 1995, after which the number stabilized or decreased (Blew and Südbeck, 2005; Pollitt *et al.*, 2003). If only the period from 1980 to 1995 is considered, the yearly increase was 2.5% for Curlews in Great Britain and 5.1% for Curlews in the International Wadden Sea. The yearly increase in the International Wadden Sea was still twice as high as in Great Britain.

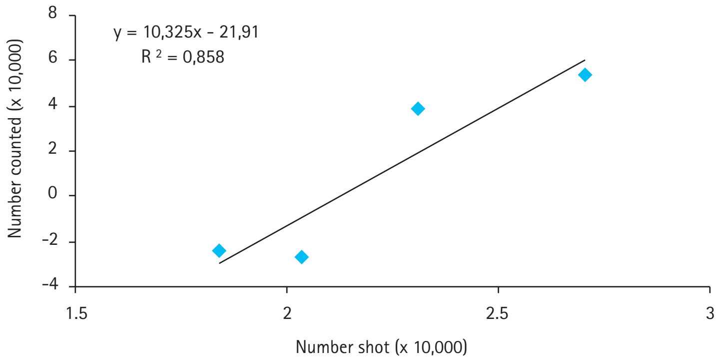

Figure 2: Relationship between annual number of Curlews shot (t_0) during 1976-1981 and the number of Curlews counted (t_0-t_1) during winter in the Dutch Wadden Sea. Severe winters were excluded from the analyses. Also given is the regression model and regression coefficient (R^2).

2.1.2 Relationship between shooting pressure in Denmark and Curlew number

The number of Curlews shot was on average 28,900 birds before 1981 (Figure 1), and 8,900 birds during 1982-1993. The figures show that a large difference in hunting pressure in Denmark occurred before and after 1981, therefore the analysis was divided into these two periods. Unfortunately, a comparison of the number of Curlews shot in Denmark in the period before 1981 with the number counted in the International Wadden Sea is not possible because these counts were initiated in 1980, which gives too little data for a calculation. However, data for Curlew was used in The Netherlands from as early as 1976, which gives more years for a comparison (van Roomen *et al.*, 2004). This data could be used for the analysis, because of a significant correlation between numbers counted in The Netherlands and the numbers counted in the International Wadden Sea (parameter estimate = 2.11; R^2 = 0.76; p < 0.001; N = 0.21; regression analysis). The result shows that it makes good sense to use the Curlew counts from The Netherlands as a rough substitute for the International Wadden Sea counts.

The number of Curlews shot in Denmark was compared to the number counted in The Netherlands during 1976-1981 and 1982-1993. The number of Curlews shot in year t_0 (*e.g.*1978) was analyzed in relation to the difference between Curlew numbers in year t_0 (*e.g.* 1978) and year t_1 (*e.g.*1979). The analysis showed a good correlation between the number of Curlews shot in Denmark and the number of Curlews counted in The Netherlands during midwinter 1976-1981 despite the low number of observations (parameter estimate = 10.33; R^2 = 0.86; p = 0.07; N = 4; regression analysis) (Figure 2). However, during 1982-1993 the correlation between the Curlew number shot and the number of Curlews counted was weak (parameter estimate = -1.93; R^2 = 0.01; p = 0.84; regression analysis). The result indicates that during the period with a high shooting pressure in Denmark there was a correlation between the number of Curlews shot and the number counted in The Netherlands. As opposed to this there was no correlation between this data during 1982-1993, the period with a low shooting pressure on Curlews in Denmark.

Examination of the preconditions showed an indication of a separate sub-unit of the Curlew flyway using the International Wadden Sea on a regularly basis. In addition, a correlation was demonstrated between a period with high shooting pressure on Curlews in Denmark and the number of Curlews wintering in the Dutch Wadden Sea.

2.2 Model

2.2.1 Population

To examine the hypothesis that the hunting regulation in Denmark in 1982 and 1994 had an effect on the number of Curlews in the International Wadden Sea, a model was constructed. It was based on production of fledglings, survival of juveniles and adults and the population size in the international Wadden Sea in January 1982. It is ignored that a part of the Curlews winters in France. The number of Curlews counted in the International Wadden Sea in 1982 was about 87,000 individuals (see Figure 4.44 in Blew *et al.*, 2005, this volume). From Meltofte *et al.* (1994) it appears that about 70% of the Curlews counted in West Europe during winter were adults and 30% were juveniles, giving the following figures for 1982: 61,000 adults (30,500 pairs) and 26,000 juveniles. The number of fledglings for pairs of Curlews is between 0.1-1.4 (Henriksen, 1991). In the following calculations the number of fledglings is assumed to be 0.75 per year. Curlews are breeding in their second year. The yearly survival rate of juveniles is 47.5% and for adults 83%

(Bainbridge and Minton, 1978; Kipp,1982; Evans and Pienkowski, 1984).

It was assumed that the reduced number of Curlews shot in Denmark after 1982 and 1994 increased the survival rate of Curlews in the following years. Further, it was assumed that the survival rate increased by the same percentage as the reduced number of birds shot in relation to the population number in the International Wadden Sea, *i.e.* that the shooting in Denmark was additional to other death causes. The number of Curlews shot by hunters decreased by 15,000 birds from 1980 to 1982 (Figure 1), 10% of these were adults and 90% juveniles according to a wing survey of shot Curlews (Clausager, pers. comm.). The number of Curlews wintering in the International Wadden Sea region in 1982 was estimated at 87,000 (see Figure 4.44 in Blew *et al.*, 2005, this volume). According to the assumption that the protection in 1982 and 1994 raised the yearly survival rate of Curlews, the increase in survival from 1983 and onwards was 17.2 % (15,000 x 100/87,000). Since adults made up 10% of birds shot and juveniles 90%, the yearly increased survival rates for adults were 0.017 (0.172 x 0.1) and for juveniles 0.155 (0.172 x 0.9).

The population number in 1993 had to be used to calculate the further increase in yearly survival from 1994 and onwards. From the model it was estimated that there were 238,800 Curlews in 1993. From 1993 to 1994 5,200 Curlews were not shot, which increased the yearly survival during the following years by 2.2% (5,200 x 100/238,800). According to wing surveys of Curlews shot 7% were adults and 93% juveniles after 1982 (Clausager, pers. comm.). Using this information, the survival rate for adults increased by 0.0015 (0.022 x 0.07) and for juveniles by 0.0205 (0.022 x 0.93).

The midwinter count result indicated that the Curlew numbers in the International Wadden Sea increased up to 1995, and stabilized or decreased in the years after (see Figure 4.44 in Blew *et al.*, 2005, this volume). This was incorporated into the model.

2.2.2 Temperature

The winter climate influences the midwinter number of Curlews in the International Wadden Sea, therefore it is necessary to incorporate this effect in the model. Since the number of Curlews increased during the period, it was necessary to convert the figures into stable numbers before calculating the relationship between Curlew number and winter climate. The number was converted by using the calculated yearly increase from the population model. After this the relationship between Curlew number and winter temperature was estimated ($R^2 = 0.33$; $p < 0.01$, N = 21; regression analysis) as

y = 9798x + 86518;
y = number of Curlews,
x = winter temperature (mean of December and January, measured at Eelde, The Netherlands).

Though there is an overall significant relationship between Curlew number and midwinter temperature, the correlation below 0° C is not simple and linear. The relative low values of R^2 indicate this.

3. Results

3.1 Numbers

In the International Wadden Sea the midwinter Curlew number increased from 1980-2000 (see Figure 4.44 in Blew *et al.*, 2005, this volume). The yearly increase was calculated as 3% (Table 1). The number of Curlews counted varied from year to year, due to winter temperature (see above).

In the Danish Wadden Sea, Curlew midwinter numbers during 1980-2000 also increased by the same percentage as in the International Wadden Sea (Table 1, Figure 3A). The midwinter number in the Danish Wadden Sea was also influenced by winter climate (parameter estimate = 374; R^2 = 0.35; $p < 0.01$; N = 20. regression analysis). The increase in numbers was most pronounced after 1988 (mild winters) and again after 1998 (protection of most of the Danish Wadden Sea). The Curlew numbers from 1998-2000 were different from numbers in 1980-1997, even though the number of observations was low (T value = 5.14; $P < 0.001$, $N_1 = 18$, $N_2 = 3$; T-test, data was log transformed and corrected for unequal variance). Comparison between the index of Curlews counted and the index based upon the estimated number from the model (see below) indicates that the increase from 1983 to 1997 was lower in the Danish Wadden Sea than in the International Wadden Sea as a whole. Only in the years after 1998, when shooting was forbidden in most of the Danish Wadden Sea, do the Curlew numbers rise to the same relative level as in the International Wadden Sea.

Also the autumn Curlew numbers in the Danish Wadden Sea increased during 1980-2000 (Figure 3B, Table 1). However, the numbers were at a rather low level up to 1992, after which they increased markedly until 1995. Subsequently the number leveled off but stayed at a higher level than during the first part of the period. Also the numbers from 1980-1991 were lower than the numbers in 1992-2000, the period with large areas protected from shooting Curlews in the Danish Wadden Sea (T value = 5.56; $P < 0.001$; $N_1 = 12$, $N_2 = 9$; T-test, data was log transformed and corrected for unequal variances). Comparison between the index of Curlews counted and the index based upon the estimated number from the model shows that the index of counted birds was low in the Danish Wadden Sea from 1983 to 1992 (Figure 3B). After 1992, the index of counted Curlews in the Danish Wadden Sea was higher that the index of the model indicating that the numbers of

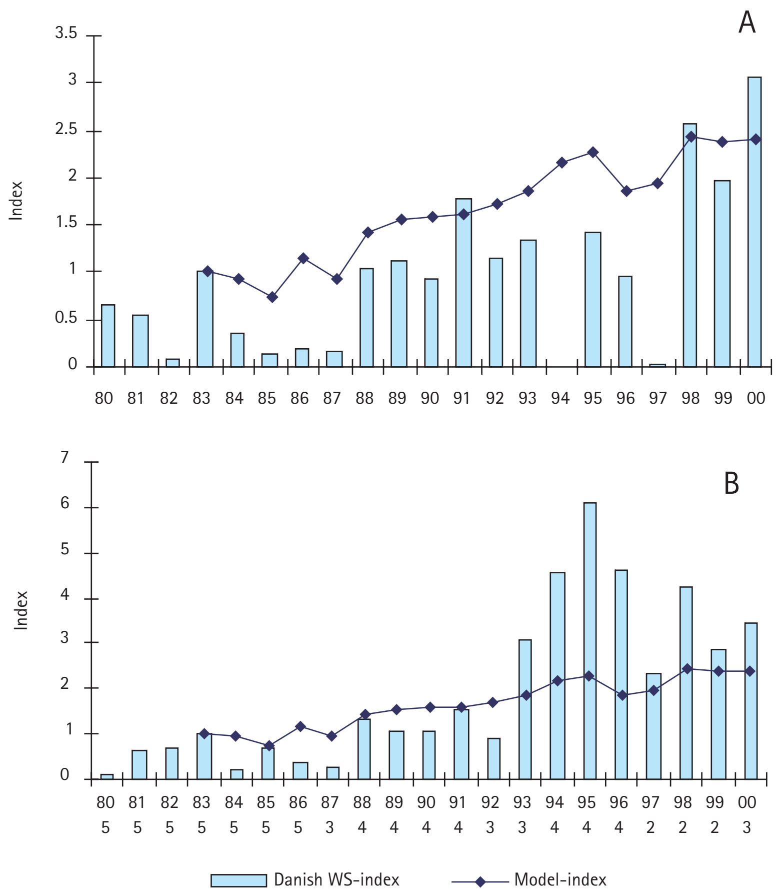

Figure 3: Indexes of Curlews in the Danish Wadden Sea 1980-2000 together with estimated indexes from the model (1983-2000, see text). The year 1983 was used as a base year for the calculation of indexes. A: midwinter, counts from ground. B: autumn, counts from aircraft.

Curlew in the Danish Wadden Sea increased more than in the Wadden Sea as a whole. This increase in numbers in the Danish Wadden Sea coincides with shooting protection of large areas.

3.2 Model

The model is based on a yearly increase survival rate due to the shortening of the open season by one month for shooting Curlews in Denmark after 1982, a total protection after 1993, and the effect of winter temperature and an apparent stabilization of the Curlew numbers after 1995 (Figure 4).

The model seems to estimate the Curlew numbers rather well in most years, for example, in the period 1988-1995. On the other hand, the estimated numbers in winters with low temperature are rather low *e.g.* 1987 and 1996-1997. The reason for this is a rather poor correlation between midwinter numbers and temperature. To predict these figures a more sophisticated temperature model is needed. The yearly increase rate during 1983-2000 calculated for the estimated results based upon the model is 9.8%, which is in the same order of magnitude as the yearly increase (6.4%) in the Curlew numbers counted during the same period.

The estimated numbers from the model were tested against the number of Curlews counted in the International Wadden Sea ($X^2 = 256620$; $P << 0.0001$; df = 18; Chi-Square Goodness of Fit). The result showed a statistical significant difference between the estimated figures for Curlews and the number counted in the Wadden Sea.

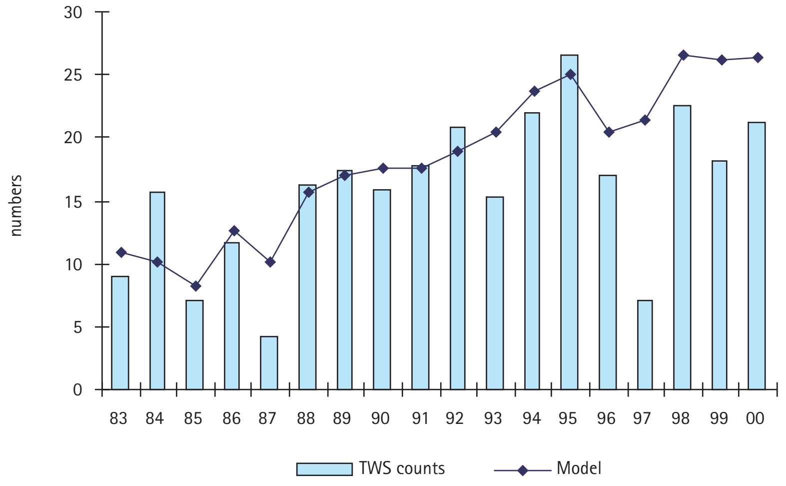

Figure 4: Number of Curlews during 1983-2000 recorded by the Trilateral Wadden Sea counts (TWS) in the International Wadden Sea during winter together with numbers estimated from the model based on increased survival due to reduced shooting of Curlews in 1982 and a ban on Curlew shooting in 1994. Effect of winter temperature and stabilization of the Curlew numbers after 1995 are included in the model (see text).

4. Discussion

4.1 Numbers

Comparing the International Wadden Sea numbers and trends of Curlews to numbers in the Danish Wadden Sea risks a very high degree of autocorrelation; however, only up to 5% of the Curlews during winter stage in the Danish Wadden Sea. Thus, the two samples can be considered as independent.

The west European flyway population of Curlews is estimated at about 420,000 birds and is stable or increasing (Wetlands International, 2002). The breeding population numbers about 150,000 pairs (Meltofte *et al.,* 1994). The Curlew breeds in West Europe and Russia, and winters in West and South Europe, Africa and Asia. The wintering numbers in the International Wadden Sea are about 200,000 Curlews in 2000 (see Figure 4.44 in Blew *et al.,* 2005, this volume).

It was found that the midwinter counts in the Danish Wadden Sea and the International Wadden Sea both increased during the period 1980-2000, and that they were both influenced by the winter climate. Meltofte *et al.* (1994) also found that the winter climate influenced the number and the geographical distribution of the Curlew in the International Wadden Sea.

The midwinter counts in the Danish Wadden Sea were performed in mid January, two weeks after the open season ceased for Curlews and other waterbirds. During midwinter, there was no clear increase in the numbers after 1992 when large areas in the Danish Wadden Sea were closed for shooting. However, after 1998 when most of the Danish Wadden Sea was protected the Curlew number increased (Figure 3A). This result is somewhat opposite to the results during autumn (Figure 3B), when a clear effect appeared after shooting protection of large areas in the Danish Wadden Sea in 1992. There is no clear explanation for this difference between the results in autumn and winter. However, the midwinter counts took place shortly after the hunting season stopped where shooting had been practiced during four months. If the areas protected from shooting in 1992 were to small to hold Curlews for a longer period, the birds had to leave the Danish Wadden Sea during autumn. The results indicate that this could be an explanation, since a clear increase in Curlew numbers took place in 1998 when most of the Danish Wadden Sea was protected from shooting. On the other hand, during autumn a constant flow of Curlews pass through the Danish Wadden Sea and an increasing number stage for a shorter period in some of the protected areas after 1992 and increased the number counted. Also disturbance from shooting was less after 1992, which probably made the Curlews less shy. This could have increased the registration possibilities, especially when counting from aircraft, which was the platform used during the autumn counts in the Danish Wadden Sea. Thus, the effect on Curlew numbers in the Danish Wadden Sea can be considered as a change in geographical distribution due to shooting protection of areas and a reduction of the Curlews shyness facilitating a higher registration possibility.

4.2 Model

The model predicts an increase of Curlew numbers in the International Wadden Sea, which seems to explain the general population increases recorded by the Trilateral Wadden Sea counts. But the model is simple and does not include the fact that the hatching success and survival rate of fledglings varies from year to year, as does the autumn mortality. In addition severe winters act in at least two ways on the Curlews, they increase the mortality due to lack of food, and a larger part of the birds move further south to France, where hunting activity increases mortality. These factors are not included in the model.

In the International Wadden Sea the model fits the number counted during most of the years from 1988 to 1995 (Figure 4). Exceptions are either years with low temperatures or in the years after 1995, when decreasing numbers were counted. A test of goodness of fit between the counted and estimated numbers showed significant differences between the two data sets. This means that the model does not explain the observed Curlew numbers to a convincing degree. This is primarily caused by a poor relationship between winter temperature and the number of birds counted in the International Wadden Sea. In addition, we have no evidence of the background for the stabilization or decrease in Curlew numbers after 1995, which made it difficult to build this into a model. However, the model is able to show almost the same yearly increase, some effects of winter temperature and estimates almost the same yearly figures as the counted number in the International Wadden Sea. This result indicates that the general increase in the Curlew numbers counted in the International Wadden Sea from 1983 to 1995 was probably caused by increased protection of the species in Denmark in 1982.

The estimated index based on the model made a general overestimation of the increase in the Danish Wadden Sea during autumn (Figure 3A). Part of this overestimation is caused by the relatively high level of the base year (1983). If this level were lower as in the years before and after there would have been a better fit between the number counted and the number estimated by the model. With a lower level in the base year the difference between the model and number counted after 1998 would also have been larger. This would have increased the shown effect on Curlews of closing almost the entire Danish Wadden Sea for shooting in 1998 (Figure 3A).

During autumn in the Danish Wadden Sea the index of Curlew numbers counted was below the estimated index up to 1992 (Figure 3B). In the following years the number of counted Curlews was higher that the number estimated from the model. This result suggests that closing of large areas for shooting in the Danish Wadden Sea in 1992 increased both the number of Curlews in the following years but also influenced their behavior, by reducing the escape distance, as already discussed. From other studies, it is known that a shooting ban in large areas can increase the number of waterbirds in the following years by a factor 2-3 (Madsen, 1998). The same effect is seen on the number of Curlew in the Danish Wadden Sea after shooting was stopped in large areas after 1992.

4.3 Conclusion

It is concluded that the general increase of numbers of Curlews in the International Wadden Sea could be explained by the increased hunting protection of the species in 1982 and 1994 in Denmark. The assumption that hunting mortality could be additional to other causes of death is supported by a model in which the hunting mortality of Curlews in Denmark was added to the general mortality in the years after hunting was reduced or stopped. The largest effect on the survival was the reduction of the open season for Curlew by one month from 1982 and onwards. The protection regulations probably caused an increase in the survival rate of Curlews, which raised the population number in the following years. A model suggesting that the increased survival rate of the same order of magnitude as the number of Curlews previously shot fits the number of counted birds in 1983-2000 in the International Wadden Sea in most years. This suggests that the results from the model are within a realistic range. Closing of large areas for shooting in the Danish Wadden Sea in 1992 and a ban on shooting in most of the Danish Wadden Sea in 1998 affected also the number of Curlews, but only locally.

Acknowledgements

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WADDEN SEA ECOSYSTEM No. 20

Shellfish-Eating Birds in the Wadden Sea - What Can We Learn from Current Monitoring Programs?

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Summaries

Summary

The Trilateral Wadden Sea Monitoring revealed a strong decline during the 1990s of the European Oystercatcher (*Haematopus ostralegus*), a probable decline of the Herring Gull (*Larus argentatus*) and since winter 1996 a decline of the Common Eider (*Somateria mollissima*). All three species feed on large shellfish species (*Mytilus edulis, Cerastoderma edule*), which are also commercially exploited by fisheries.

In this contribution we investigate the different fishing regimes in the four Wadden Sea regions in relation to the conflict of shellfish eating birds vs. fisheries. We calculate biomass consumption for the three bird species and relate those to the landings of mussels and cockles. Additionally, we investigate the numbers and spatial variation of wintering Common Eiders. Of the three bird species, the Common Eider is the most important predator, with regional differences in its importance.

In all countries but Denmark, biomass consumption by Oystercatchers declined strongly between 1993 and 1999. There was a negative correlation between mussel landings and the consumption by Common Eider and Oystercatcher for the entire Wadden Sea, which could indicate an existing conflict between fisheries and birds. The numbers of wintering Common Eiders in the Wadden Sea averaged around 280,000 birds for the years 1985–2000. However, between countries and Wadden Sea regions numbers fluctuated independently, indicating an opportunistic choice of the wintering site. Birds seem to shift between areas and showed highest fluctuations where they had to rely on one single food source. Due to food shortage a large drop in numbers together with a high mortality occurred after 2000.

The trilateral Wadden Sea monitoring has delivered highly valuable data about the decline of shellfish-eating birds. However, the level of sustainable fishing cannot be determined on the basis of this data. To answer this complex ecological topic a combination of the monitoring with a modeling approach, based on sound studies of the foraging ecology for each species is needed.

Sammenfatning

Det trilaterale overvågningsprogram for Vadehavet afslørede en stærk nedgang i 1990´erne i antallet af Strandskader (*Haematopus ostralegus*), en sandsynlig nedgang i antallet af Sølvmåger (*Haematopus ostralegus*), og siden vinteren 1996, en nedgang i antallet af Ederfugle (*Somateria mollissima*). Alle tre arter fouragerer på større skaldyr (*Mytilus edulis, Cerastoderma edule*), som også udnyttes kommercielt.

I det foreliggende bidrag undersøger vi de forskellige fiskerireguleringer i de fire Vadehavsregioner i relation til konflikten mellem på den ene side de fugle, som fouragerer på skaldyr og på den anden side fiskeriet. Vi beregner biomasse føden for de tre arter, og relaterer det til landingerne af blå- og hjertemuslinger. Derudover undersøger vi antallet og den geografiske fordeling af overvintrende Ederfugle. Ederfuglen er med regionale forskelle i forekomsten den vigtigste predator af de tre nævnte arter.

Med undtagelse af Danmark var der en stærk nedgang i biomasse føden for Strandskade mellem 1993 og 1999. Der var en negativ korrelation mellem landinger af blåmuslinger og fødeoptag af Ederfugle og Strandskader i hele Vadehavet, hvilket kan indikere en eksisterende konflikt mellem blåmuslingefiskeriet og fuglene. Antallet af overvintrende Ederfugle lå gennemsnitligt på omkring 280.000 for 1985-2000. Antallet svingede dog mellem landene og de enkelte Vadehavsregioner, hvilket indikerer et opportunisk valg af overvintrings lokaliteter. Fuglene synes at skifte mellem de forskellige områder. Største udsving forekom, hvor de var afhængige af én enkelt fødekilde. Et stort fald i antal sammen med en høj dødelighed forekom efter 2000 p.g.a. fødemangel.

Det trilaterale moniteringsprogram har givet særdeles værdifulde data omkring faldet i de arter, der fouragerer på skaldyr. Niveauet for et bæredygtigt fiskeri kan dog ikke fastlægges på grundlag af disse data. For at kunne besvare dette komplekse økologiske spørgsmål er det nødvendigt at kombinere overvågningen med modeller, som er baseret på solide studier af fourageringsøkologien for hver af de omtalte arter.

Zusammenfassung

Das trilaterale Wattenmeermonitoring zeigte für die 1990er Jahre einen starken Rückgang des Europäischen Austernfischers (*Haematopus ostralegus*), einen wahrscheinlichen Rückgang der Silbermöwe (*Larus argentatus*) und seit 1996 einen Rückgang der Überwinterungspopulation der Eiderente (*Somateria mollissima*). Alle drei Vogelarten ernähren sich hauptsächlich von großen Muschelarten (*Mytilus edulis*, *Cerastoderma edule*), die gleichzeitig durch kommerzielle Fischerei genutzt werden.

In diesem Beitrag untersuchen wir die unterschiedlichen Fischereiregulierungen der vier Wattenmeerregionen in Bezug zum Konflikt zwischen muschelfressenden Vögeln und der Fischerei. Dazu berechneten wir die Biomassekonsumtion der drei Vogelarten und setzten sie in Bezug zu den Mies- und Herzmuschelanlandungen durch die Fischerei. Zusätzlich untersuchten wir die Variation der Anzahlen und der räumlich Verteilung der Eiderente. Von den drei untersuchten Vogelarten ist die Eiderente, mit regionalen Unterschieden, der wichtigste Biomassekonsument.

In allen Ländern, außer Dänemark, nahm die Biomassekonsumtion durch Austernfischer zwischen 1993 und 1999 stark ab. Für das gesamte Wattenmeer gab es eine negative Korrelation zwischen den Muschelanlandungen und der Konsumtion durch Eiderente und Austernfischer, was auf einen Konflikt zwischen Fischerei und Vögel hindeutet. Die Anzahl der im gesamten Wattenmeer überwinternden Eiderenten schwankte in den Jahren 1985-2000 um 280.000 Enten. Jedoch fluktuierten die Winterzahlen in den einzelnen Wattenmeerregionen unabhängig voneinander, was auf eine opportunistische Wahl des Überwinterungsgebietes hindeutet. Die Enten schienen zwischen den Gebieten zu wechseln und zeigten die höchsten Fluktuationen in Gebieten, in denen sie von einer einzelnen Nahrungsressource abhängig waren. Aufgrund einer Nahrungsverknappung trat ab dem Jahr 2000 ein starker Rückgang der Eiderentenzahlen, verbunden mit einer hohen Mortalität auf.

Das trilaterale Wattenmeermonitoring konnte wertvolle Daten über den Rückgang muschelfressender Vögel liefern. Jedoch kann das Niveau einer nachhaltigen Muschelfischerei nicht allein auf der Basis der Monitoringdaten bestimmt werden. Zur Beantwortung dieser komplexen ökologischen Frage ist eine Kombination des Monitorings mit Modellierungsansätzen, basierend auf fundierten nahrungsökologischen Studien der einzelnen Arten, notwendig.

Samenvatting

Resultaten van de trilaterale monitoring in de Waddenzee wijzen er op dat in de jaren negentig van de vorige eeuw een sterke afname plaatsvond van Scholekster (*Haematopus ostralegus*), Eider (*Somateria mollissima*) (sinds 1996) en waarschijnlijk ook van Zilvermeeuw (*Larus argentatus*). Alle drie de soorten hebben gemeen dat ze voor een belangrijk deel van hun voedsel afhankelijk zijn van schelpdieren, met name Mosselen *Mytilus edulis* en Kokkels *Cerastoderma edule.*

Voor beide prooien concurreren de vogels met de commerciële visserij. Het mogelijke conflict tussen vogels en visserij werd onderzocht aan de hand van de visserijregimes in de vier verschillende Waddenregios (Nederland, Nedersaksen, Sleeswijk-Holstein, Denemarken). Consumptie door de drie soorten werd vergeleken met gegevens over de hoeveelheden opgeviste Mosselen en Kokkels. Daarnaast werd de verspreiding van Eiders geanalyseerd. Van de drie vogelsoorten is de Eider de belangrijkste schelpdier-consument, zij het wel met regionale verschillen.

Met uitzondering van Denemarken nam de consumptie van scheldieren door Scholeksters sterk af tussen 1993 en 1999. Bovendien werd een negatief verband gevonden tussen de hoeveelheid opgeviste schelpdieren en de aantallen Eiders en Scholeksters in de internationale Waddenzee, wat wijst op een mogelijk conflict tussen vogels en visserij. Het aantal overwinterende Eiders in de internationale Waddenzee bedroeg gemiddeld zo'n 280.000 vogels in de periode 1985-2000. Tussen de vier regio's bestaan echter grote verschillen in trends, wat er op wijst dat geen sprake is van vaste overwinteringsplaatsen. Er is veelvuldig sprake van verplaatsingen, en gebieden met grote fluctuaties worden gekenmerkt doordat ze slechts één voedselbron herbergen. Door voedselschaarste en daaropvolgende sterfte vond een sterke afname van Eiders plaats vanaf 2000.

Dankzij de trilaterale monitoring kunnen de aantalsveranderingen van de scheldiereters (en andere soorten) nu goed worden gedocumenteerd. Echter, het zal niet mogelijk zijn op grond van de hier gepresenteerde uitwerking tot een duurzaam concept voor schelpdier-visserij te komen. Hiervoor zijn meer modelstudies, alsmede meer kennis omtrent de voedselecologie van de vogels noodzakelijk.

1. Introduction

The Joint Monitoring Project for Migratory Bird in the Wadden Sea (JMMB) was set up within the framework of the Trilateral Wadden Sea Monitoring (TMAP) to observe changes in peak numbers, changes in spatial and temporal patterns, and intensity of usage by migratory bird species in the European Wadden Sea (Rösner *et al.*, 1994). This monitoring provides a good overview of bird numbers utilizing the Wadden Sea at different stages of the annual cycle. One result of the recent data analysis, underlining the importance of the monitoring program, was a substantial overall decrease of Oystercatcher (*Haematopus ostralegus*) numbers plus indications for an overall decrease of Herring Gulls (*Larus argentatus*) 1992-2000; for the Common Eider (*Somateria mollissima*) winter numbers decreased from 1996 onwards (Blew *et al.*, 2005).

Bivalves form a major part of the biomass in the Wadden Sea. In particular the Blue Mussel (*Mytilus edulis*) and the Edible Cockle (*Cerastoderma edule*) can dominate intertidal benthic communities in terms of biomass and production. Several bird species have specialized in exploiting this prominent food resource. Major predators of these bivalve species in the Wadden Sea are the Common Eider, the European Oystercatcher, and the Herring Gull. Together they contribute 50% of the annual consumption by carnivorous birds in the Wadden Sea (Scheiffarth and Nehls, 1997). On natural mussel beds these species can consume a substantial part of the annual production (Nehls *et al.*, 1997). The contribution of different prey species in the diet of these species varies depending on the natural fluctuations in the bivalve stocks (Zwarts *et al.*, 1996).

Shellfish fisheries have a long tradition in the Wadden Sea (Buschbaum and Nehls 2003). However, since the intensification of this economic activity in the 1950s, conflicts between fishermen and conservationists have arisen, in particular in years when mussel and cockle stocks were low. To protect bivalve stocks, as well as their natural predators, different management regimes have been set up in the Wadden Sea countries (CWSS, 2002 b). Nonetheless, overfishing of cockles and mussels has occurred, resulting in food shortages and consequently elevated mortality in bivalve feeders in the Wadden Sea (*e.g.* Smit *et al.*, 1998; Camphuysen *et al.*, 2002) and elsewhere in Europe (Atkinson *et al.*, 2003; Goss-Custard *et al.*, 2004).

In this contribution we evaluate whether data obtained within the framework of the trilateral Wadden Sea monitoring TMAP is sufficient to answer complex ecological questions as a basis for management decisions. We try to elucidate whether we can investigate the influence of shellfish fisheries on shellfish eating birds with the data available within the trilateral monitoring program. The role of the most important avian predators in the Wadden Sea ecosystem is examined by estimating the food consumption on the basis of bird numbers and the specific energy demands for each species considered. Landings of marketable mussels and cockles are used as parameters reflecting the spatial and temporal patterns of bivalve stocks in the area. Additionally, we try to estimate in how far fluctuating food stocks are responsible for shifts in the spatial distribution of wintering Common Eiders, the most important consumer of bivalves in the Wadden Sea.

2. Methods

2.1 Available monitoring data

Monitoring responsibilities differ between countries bordering the Wadden Sea. In The Netherlands and Denmark, monitoring is carried out by national organizations. Within the federal German system the federal states are responsible for monitoring the Wadden Sea, namely Niedersachsen, Hamburg, and Schleswig-Holstein. To account for this distinct administrative organization, the different areas are termed here Wadden Sea *regions*.

For the present analysis data from different monitoring projects was available. Within TMAP, area and density of intertidal mussel beds are estimated. Numbers of coastal breeding birds are estimated every 5 years for the entire Wadden Sea, supplemented by annual surveys on some 80 sample plots (Rasmussen *et al.*, 2000). Migratory birds are synchronously counted each January in the entire Wadden Sea area with additional counts in other months. Additionally, each spring tide non-breeding birds are counted in selected sample areas (Blew *et al.*, this report). Since Common Eiders are not well covered by land based counts, aerial counts are conducted at least once per winter. Further details of the data will be given in each part introducing the data.

2.2 Assessment of mussel and cockle stocks

During the last 10 years monitoring of intertidal Blue Mussels has been carried out in the course of national programs and as a contribution to TMAP in all countries (cf. CWSS, 2002 b; CWSS 2002, c). However, data about biomass and the area covered by mussel beds was not available for all regions for the time period 1993 - 2000, so this data could not be used for analysis. Later on, large scale data about subtidal mussels and cockles is only available for The Netherlands. As no comparable long term data about the shellfish stock which covers the entire Wadden Sea area adequately is available, yearly landings of mussels and cockles were used as an indicator of the food stocks. Since shellfish landings depend on many more factors than natural circumstances, they form only a very rough estimate of shellfish stocks (Smit *et al.* ,1989). In addition, in The Netherlands mussel seed is brought from the Wadden Sea to culture lots outside the Wadden Sea in Zeeland, so that the Mussel production and extraction by fisheries in the Dutch Wadden Sea is much higher than landings suggest. A comprehensive summary of shellfish fishing policies for the 1990s in the different Wadden Sea regions is given in CWSS (2002 b). Data about shellfish landings was provided by the CWSS (CWSS, 2002; TMAP).

2.3 Bird numbers

Three key-species of birds use the stock of larger shellfish in the Wadden Sea on a large scale as a food source: The Common Eider, the European Oystercatcher and the Herring Gull. Eiders and Oystercatchers may shift their diet between Mussels, Cockles and other shellfish (Zwarts et al. 1996) depending on the availability of food resources. The Herring Gull uses a broad variety of food resources, but is an important predator on young Mussel beds (Hilgerloh et al. 1997).

For a calculation of the total numbers of the target bird species, numbers of breeding, migratory and wintering birds had to be combined. For calculating spatial variation in consumption by birds, the total number of birds for each species, month and country was estimated; complete data for this exercise was only available for 1993 to 2000.

Numbers of non-breeding Oystercatchers and Herring Gulls were taken from synchronous counts with imputed numbers to account for missing data (Blew *et al.*, this report). Over the entire period no counts were available for July in Denmark. To compensate for this, the relation in numbers between July and August was calculated from the spring-tide counts in Denmark. Using this relation, July numbers in Denmark were calculated from the available August numbers.

The numbers of Common Eiders were calculated on the basis of aerial counts, since this species uses mainly remote areas which are often impossible to count from the ground. Between the four regions the seasonal counting coverage varied strongly, with aerial counts in The Netherlands only available for the months of January and February (Figure 1). For the Danish part, seasonal coverage was quite complete. Apart from July, any missing data was imputed (Blew *et al.*, this report). For Schleswig-Holstein and Niedersachsen the phenologies derived from the results of all aerial counts in each region in the years 1986–2003 were used as a pattern to estimate the Eider numbers in months when no aerial counts were carried out. In The Netherlands Eider numbers were calculated on the basis of the counting results in January or February according to the phenology observed in Niedersachsen. The seasonal pattern given by Swennen *et al.* (1989) for the year 1987 confirms the assumption that the overall seasonal pattern for the Dutch Wadden Sea and the adjacent North Sea coast follows the phenology observed in Niedersachsen.

The number of breeding pairs for each species was given for Germany by Hälterlein and Steinhardt (1993), Hälterlein and Südbeck (1996; 1998), Knief *et al.* (1996; 1998; 1999), Südbeck and Hälterlein (1994; 1997; 1999), for The Netherlands by Dijksen and Koks (2001) and for Denmark by Laursen (pers. comm.). Additionally, the complete survey from 1996 and the analysis of colony breeding birds by Rasmussen *et al.* (2000) were used. In Schleswig-Holstein and Niedersachsen breeding pair numbers were available for all years considered. In contrast to this, for Denmark and The Netherlands breeding pair numbers of Common Eiders and Oystercatchers were available for 1996 only and therefore this data was applied for all years from 1993 to 1999. For Herring Gull breeding pair data was available for 1993 to 1996 and was used for the calculations. To estimate the total number of birds, the number of breeding birds was added to the number of non-breeding birds from April to June for the Common Eider and the Oystercatcher, from May to July for the Herring Gull.

2.4 Calculation of consumption

Calculation of biomass consumption allows a comparison of species with different body sizes on an ecosystem level since it forms a universal currency. In addition, it is a standard measure for biomass extraction and mass flow through ecosystems (*e.g.* Asmus *et al.*, 1998). Calculation of consumption by birds follows the approach described by Smit (1981), Meire *et al.* (1994), and Scheiffarth and Nehls (1997). The number of birds in each month multiplied by the numbers of days of the respective month resulted in bird-days per month and region for each month of the years from 1993 to 1999. On the basis of these parameters, monthly consumption and total consumption for each year were calculated.

For the Common Eider the seasonal pattern of daily food requirements is known from a detailed foraging study by Nehls (1995). Daily biomass intake per bird for this species varies between 130 g AFDM in summer and 180 g AFDM in winter. Monthly bird days were multiplied by daily biomass intake to yield monthly food consumption.

For the Oystercatcher and the Herring Gull until now no field studies of daily food requirements are available. Therefore, seasonally differentiated values for food intake were calculated by the fol-

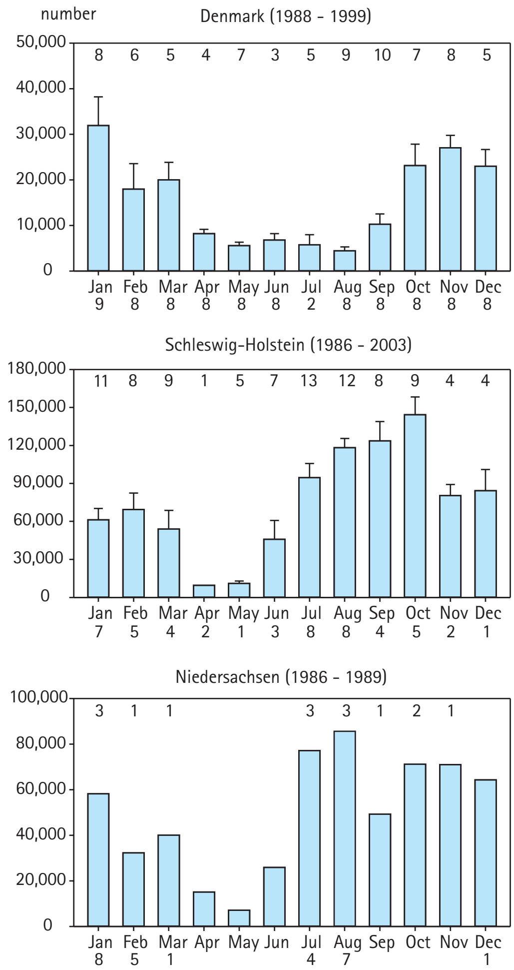


Figure 1: Phenologies of Common Eider (*Somateria mollissima)* in different regions of the Wadden Sea (mean + SE) as obtained from aerial surveys. Figures above bars denote number of years in which birds were counted; figures below months indicate number of years of respective months used for the calculation of consumption. These numbers are sometimes higher than numbers above bars since for the calculation of consumption different years or months with a high proportion of imputed values were used which were discarded for the calculation of the phenology (see text). Phenology for Niedersachsen was taken from Nehls (1989).

lowing allometric equation relating metabolic rate to body mass (see Scheiffarth and Nehls, 1997):

$C = D * 3 * BMR * (1/Q)/E$ (equation 1), where:

C = monthly biomass consumption per species [g AFDM];

D = number of bird days per month;

BMR = basal metabolic rate, estimated by mass dependent scaling equations:

BMR [Watt] = $5.06 * W^{0.729}$ for the Oystercatcher (Kersten and Piersma, 1987; equation 2);

BMR [Watt] = $3.56 * W^{0.734}$ for the Herring Gull (Aschoff and Pohl, 1970; equation 3);

W [kg] = body mass of the target species; for each month the actual mass was used to retain a seasonal pattern.

BMR values were transformed into KJ day^{-1};

Q = assimilation efficiency (80 %; mean value of different sources; Kersten and Piersma, 1987; Castro *et al.*, 1989; Zwarts and Blomert, 1990);

E = 22 KJ g AFDW^{-1}; mean energy content of marine benthic animals in the Wadden Sea (Zwarts and Wanink, 1993)

According to the right-hand side of equation (1), for individual Oystercatchers daily consumption varied between 43.58 in May and 52.04 g AFDM d^{-1} $bird^{-1}$ in December. For the Herring Gull only a constant value of 52.62 g AFDM d^{-1} $bird^{-1}$ could be calculated since no seasonal pattern of body mass from the Wadden Sea is available. This value falls well within the range of other studies which estimated food consumption of Herring Gulls (Hilgerloh *et al.*, 1997; Nehls *et al.*, 1998).

We did not convert consumption estimates to fresh mass as this would add a large error to the consumption estimates. For relating patterns of bird consumption to patterns of shellfish landings, this step is unnecessary since the relationship is scale-independent. Nor did we 'guesstimate' the proportion of cockles and mussels in the diet, since the contribution of these prey species to the energy intake of the birds ranges from 0% to 100% and varies between years and locations.

2.5 Correlations

Patterns of annual consumption estimates and shellfish landings were analyzed for each Wadden Sea region separately. As no linear relationship between these data series can be assumed, a Spearman rank correlation was performed. Two types of correlations were tested: a) the relation between shellfish landings and food consumption in the same year and b) shellfish landings and food consumption in the preceding year. Correlation b) was assumed to be particularly important, as shellfish landed for marketing has partly grown out of the size range profitably harvestable by birds but available to them the year before. Apart from in Denmark, mussels attractive to birds are transferred to mussel cultures at least one year before they are marketed (Figure 2). Particularly if these mussels are fished in the intertidal, they are removed as a food source for Oystercatchers and Herring Gulls.

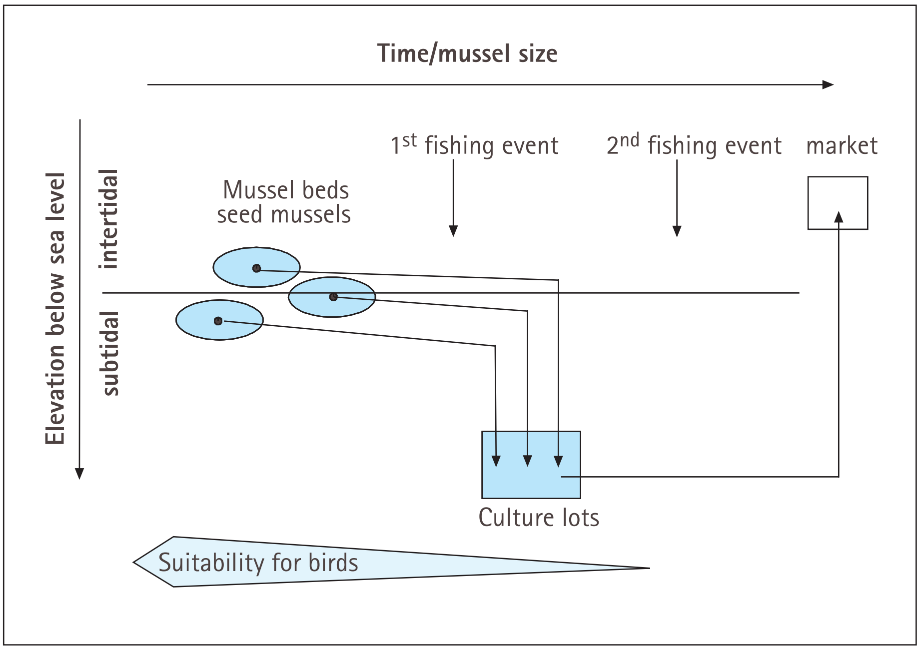


Figure 2:
Schematic representation of space and time for commercially exploited mussels (*Mytilus edulis*) in the Wadden Sea. Mussels are fished twice. Most important is the first fishing event that removes mussels from the intertidal and makes them unavailable for non-diving birds. Note that fishing for seed mussels in the intertidal is not allowed in Schleswig-Holstein.

3. Results

3.1 Shellfish landings

Shellfish landings showed considerable fluctuations in the period 1993-1999 and varied from 60,476 t (wet mass) Blue Mussels in The Netherlands in 1998 to 262 t in 1997 Denmark (Figure 3). Annual average of mussel landings for the period 1991–2000 was highest, at 37,712 t a^{-1} in The Netherlands, resulting in a fishing intensity of 0.15 t a^{-1} ha^{-1} total area (subtidal and intertidal, data from CWSS, 2002 b). At 20,837 t a^{-1}, annual mussel landings were second highest for Schleswig-Holstein, which also resulted in the second highest fishing intensity of 0.09 t a^{-1} ha^{-1}. The lowest average amount of mussels was landed in Denmark, at 4,152 t a^{-1}, resulting in a fishing intensity of 0.06 t a^{-1} ha^{-1}. In Niedersachsen, annual mussel landings amounted to 7,332 t a^{-1}, resulting in the lowest fishing intensity with 0.04 t a^{-1} ha^{-1}. The amount of mussels landed in The Netherlands and in Niedersachsen the following year was positively correlated ($r_s = 0.943$; $p < 0.01$, $n = 6$). The same correlation was found between landings in Niedersachsen and Schleswig-Holstein in the following year ($r_s = 0.829$; $p < 0.05$, $n = 6$).

In Niedersachsen, apart from few exceptions, and in Schleswig-Holstein, cockle fishing is not allowed. On average, in The Netherlands 23,215 t (wet mass, 1991-2000) and in Denmark 7,000 t (1990–1999) were landed annually. In Niedersachsen, only 53 t were harvested in 1999 (CWSS, 2002 b). Cockle landings in the various parts of the Wadden Sea were not correlated to one another or to the yields in the preceding years. Also no relations between the cockle and mussel landings could be established. For the entire Wadden Sea both mussel and cockle landings increased during the period 1993–1999 (Figure 4).

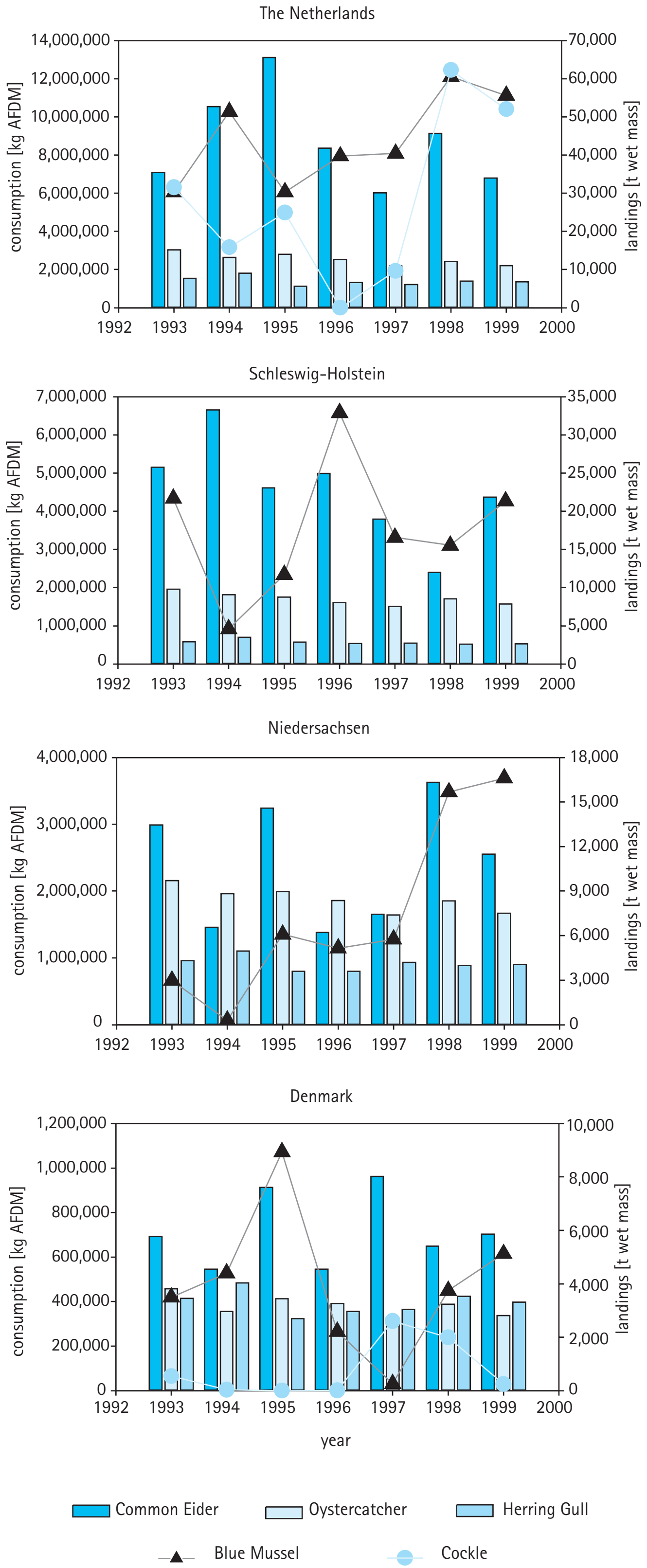
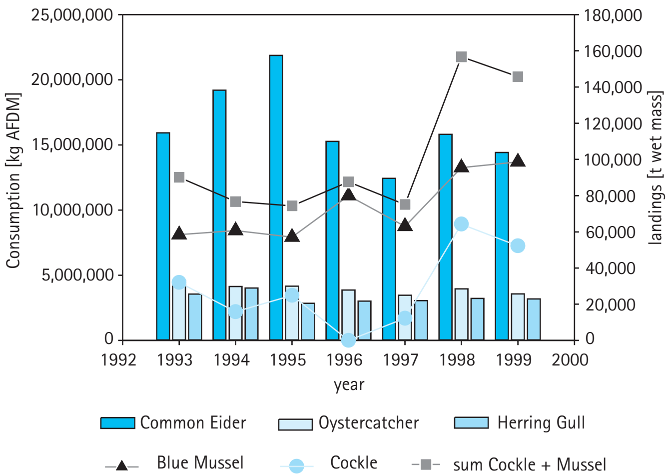


Figure 3: Consumption by major shellfish-eating birds and landings of mussels and cockles in different Wadden Sea regions. Please note the different scales on the axes.

Figure 4:
Consumption by the three major shellfish-eating birds and landings of cockles and mussels for the entire Wadden Sea.

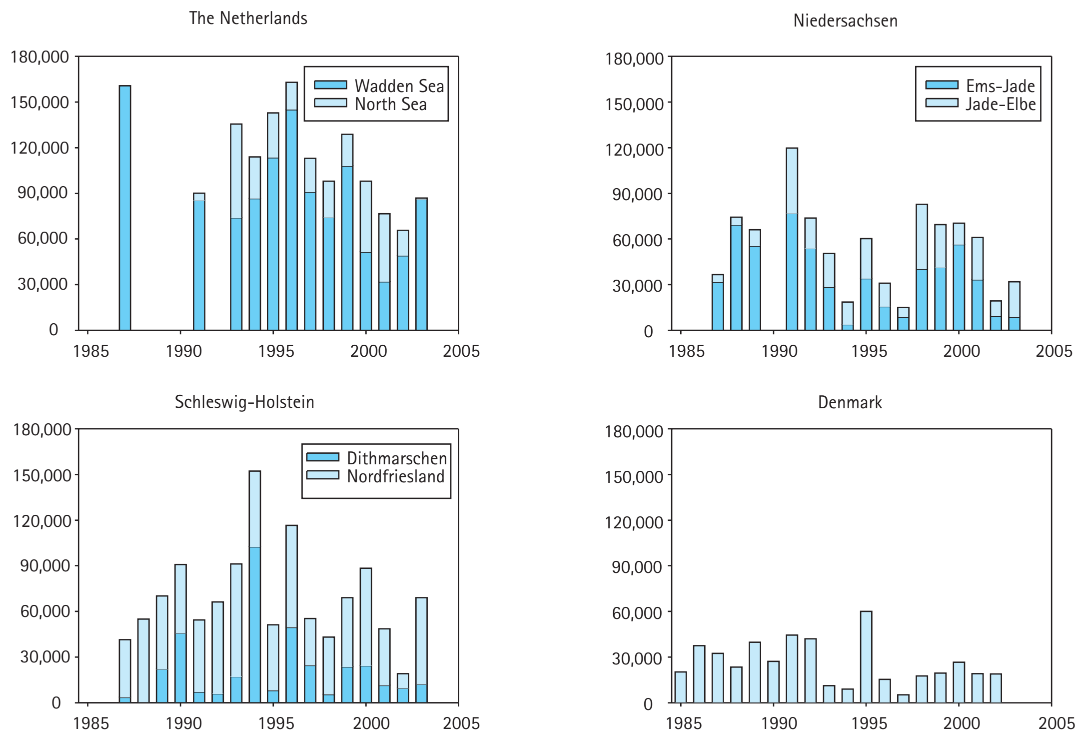


3.2 Consumption

Total consumption by the three target species, Common Eider, Oystercatcher, and Herring Gull, in the entire Wadden Sea varied between 19,000 t AFDM a^{-1} and 29,000 t AFDM a^{-1} (Figure 4). With on average 69%, the Common Eider took the largest share. For the period considered, consumption by Common Eider and Oystercatcher varied synchronously (r_s = 0.893, $p < 0.01$, n = 7). In all regions a significant positive correlation between the consumption by Eiders and the overall consumption was found, indicating the prominent status of the Common Eider in terms of biomass consumption in all regions. However, the importance of the Common Eider as a predator varied between regions, with on average 68% of the total consumption of the three species in The Netherlands, 45% in Niedersachsen, 65% in Schleswig-Holstein, and 47 % in Denmark.

In all countries apart from Denmark consumption by Oystercatchers declined significantly in the period 1993–1999 (Figure 3; The Netherlands r_s = -0.857, p = 0.014, n = 7; Niedersachsen r_s = -0.857, p = 0.014, n = 7; Schleswig-Holstein r_s = -0.821 p = 0.023, n = 7). Overall, only few correlations between shellfish landings and consumption by the three target bird species were found. Common Eider and Oystercatcher showed a weak negative

Figure 5:
Winter numbers of Common Eider in different Wadden Sea regions. For The Netherlands 'Wadden Sea' denotes the area between the islands and the mainland coast and 'North Sea' the area north of the islands. Niedersachsen and Schleswig-Holstein were subdivided in two parts. The areas Jade-Elbe and Dithmarschen are unsheltered inner parts of the German Bight whereas the Wadden Sea of the areas Ems-Jade and Nordfriesland are protected by islands and high sands against the North Sea. In years with missing bars no counting data was available.



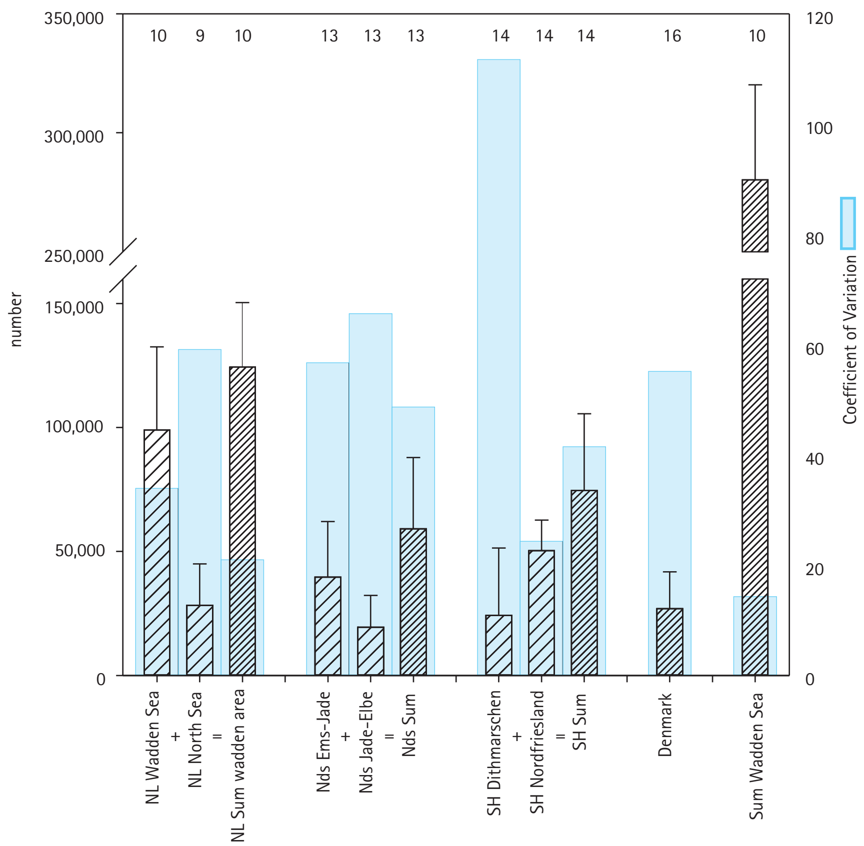


Figure 6: Numbers of wintering Common Eider in different regions of the Wadden Sea (mean + SD), based on data from Figure 5 from 1985 - 2000. Please note that if the regions were subdivided, numbers in these sub-regions, as well as the sum of the regions are presented. The blue bars show the coefficient of variation. Figures above the bars show the number of years. NL = The Netherlands, NL Wadden area = entire area between islands and mainland and North Sea adjacent to islands, Nds = Niedersachsen, SH = Schleswig-Holstein.

correlation with the total mussel landings for the entire Wadden Sea (r_s = -0.714, p = 0.071, n = 7, Figure 4). In Niedersachsen, mussel landings were negatively correlated to the consumption by Oystercatchers in preceding years (r_s = -0.886, $p < 0.05$, n = 6), which might indicate that in this region Oystercatchers and fishermen compete for the same resource of half-grown mussels in the intertidal. For The Netherlands a similar negative correlation was found for Common Eider and Blue Mussel landings in the following year (r_s = -0.771, p =0.072, n = 6).

3.3 Wintering Common Eiders

The Common Eider is the major consumer of shellfish in the Wadden Sea. This species is not only sensitive to fluctuations in the total stock of shellfish but also, because of its foraging ecology, to food quality (Nehls, 2001) which becomes particularly obvious in winter. Food quality is represented by the relationship of flesh mass to shell mass: the more flesh in relation to shell, the better and the higher the net energetic gain per food item for the birds. The total number of Common Eider wintering in the Wadden Sea area 1985-2000 varied around 280,000 individuals with numbers fluctuating independently of each other in different regions (Figure 5). The coefficient of variation in the total Wadden Sea was not higher than 14% (Figure 6). Fluctuations within the different regions of the Wadden Sea also remained comparatively small, whereas numbers counted in the sub-regions showed higher variations. A significantly positive correlation was found between the total number of wintering Eiders in The Netherlands and Schleswig-Holstein (r_s = 0.673, $p < 0.05$, n = 11), especially the northern part of Schleswig-Holstein (SH Nordfriesland, r_s = 0.618, $p < 0.05$, n = 11), which might indicate similar processes controlling Eider numbers in these two areas. The numbers counted in the southern part of Schleswig-Holstein (SH Dithmarschen) are significantly negatively correlated to the numbers in Niedersachsen (r_s = -0.571, $p < 0.05$, n = 15), which might indicate that birds shift between the two regions.

The shellfish landings were in only a few cases correlated to the number of wintering Eiders. In Denmark, the total landings of Blue Mussels and cockles were positively correlated to the number of wintering Eiders (r_s = 0.810, $p < 0.05$, n = 8).

4. Discussion

4.1 Shellfish as a food source

The shellfish landings were set in relation to the consumption by shellfish-eating birds. However, it is not clear how far these landings represent the actual food stock. At least in The Netherlands and Schleswig-Holstein mussel landings from the Wadden Sea represent the stock on subtidal culture lots out of reach of Oystercatchers and Herring Gulls (Ens *et al.*, 2002). For cockles in The Netherlands, patterns of landings and stock show some similarities, however, the percentage of the stock harvested by fishermen each year shows large variations ranging from 3% up to 38% (Smit *et al.*, 1998).

Shellfish landings have to be seen against the background of different legal regulations on the shellfish fisheries in the regions. In The Netherlands since 1991 no fishing has been practiced on intertidal mussel beds with the exception of minor fisheries in autumn 1994. In Niedersachsen, fishery of wild mussels for consumption is not allowed in the intertidal, whereas seed fishing is carried out in both the intertidal and subtidal. In Schleswig-Holstein, no mussel fishery on tidal flats and no fishery of wild mussels for consumption in the subtidal area is allowed. Seed mussels for culture lots are fished in the subtidal (CWSS, 2002 b). In Denmark no mussel cultures are allowed, so fishing is restricted to wild natural beds (CWSS, 2002 b).

Information about cockle stocks is scarce, with the exception of The Netherlands, where yearly cockle surveys are made by the RIVO-DLO. Some information is also available for Denmark (*e.g.* Kristensen, 1997). As no cockle fishery is practiced in Niedersachsen or Schleswig-Holstein, no information about the live-stock of cockles in these areas is available.

The high mortality of mussels and cockles due to severe winters and storms causes strong variations in the shellfish stock (Beukema *et al.*, 1993; Nehls and Thiel, 1993), which are reflected in the mussel and cockle landings. Although cockle and mussel landings did not correlate with each other, the influence of the hard winter 1995/1996 could be seen in both data series. At least the increase in landings the following years could be related to an increased recruitment after a cold winter. Nonetheless, only if mussel and cockle stocks fluctuate independently can they serve as an alternative food for birds (see also Zwarts *et al.*, 1996).

4.2 Consumption by shellfish-eating birds

The estimates of the consumption are constrained by several uncertainties (Scheiffarth and Nehls, 1997) with error sources occurring in two steps. First, we had to estimate the total number of birds for each country and each month. Due to a considerable shortage of data, this can only be a rough estimate of the birds actually present. Second, consumption was calculated from an allometric equation for the Oystercatcher and Herring Gull, which cannot take into account annual differences in energy demands such as varying winter temperatures. Additionally, the contribution of cockles and mussels to the diet of Common Eider, Oystercatcher, and Herring Gull is highly variable (*e.g.* Leopold *et al.*, 2001 for Common Eider).

Consumption by Herring Gull showed no relation to shellfish landings nor to the consumption by other shellfish-eating birds. This reflects the opportunistic and highly variable foraging ecology of Herring Gulls which allows easy swapping between different food sources, in contrast to Common Eider and Oystercatcher. Consumption by Common Eider and Oystercatcher correlated with each other at the level of the entire Wadden Sea. This might indicate that numbers of these species are driven by the same large-scale processes in the entire Wadden Sea. Since these patterns were not found on the regional level, regional conditions influencing numbers might differ for the two species. Considering the entire Wadden Sea, consumption by Common Eider was negatively correlated with Mussel landings, an effect which again was not found on national levels. Thus, considering the entire Wadden Sea area seems to be important, since birds can move between different localities depending on the suitability of the food supply (Scheiffarth *et al.*, 2001), as indicated by the 'wave' of mussel landings from The Netherlands to Schleswig-Holstein. For the negative correlation between mussel landings and consumption by Common Eiders different hypotheses can be formulated:

1. Mussels were concentrated on mussel cultures before being brought to market. Because of social interactions between birds, fewer birds can be supported by the same biomass.
2. In the year mussels are marketed they have grown out of the profitable size range for the Common Eider.
3. Because of a large spatfall in 1996, bird numbers could not react to the same extent as the increase in food supply. Therefore this spatfall was exploited only by fishermen and not by birds.

Distinct studies are needed to test these hypotheses, which go far beyond the current calculations.

4.3 Wintering Common Eider in the Wadden Sea

Common Eiders, mainly breeding in the Baltic, utilize the Wadden Sea area as a moulting and wintering area. The central parts of the German Wadden Sea are used as a moulting area predominantly, whereas the more peripheral parts in The Netherlands and Denmark mainly serve as wintering grounds (Swennen *et al.*, 1989). Whereas the seasonal pattern of utilization remained more or less constant, the geographical pattern of distribution changed during the 1990s. Especially the number of Eiders wintering in Denmark was comparatively low in the middle of this decade.

The case of the high fluctuations in Dithmarschen/Schleswig-Holstein demonstrates the consequences for shellfish-consuming birds relying mainly on one food species. Since almost no mussel beds exist in this part of the Wadden Sea (Nehls pers. comm.), Common Eiders have to rely entirely on cockles (Nehls, 1991). It is most likely that birds exploit this highly variable food source in years with high availability. In years with low cockle availability they have to leave the area, since no alternative food is present.

With the exception of the drop of numbers after 1996, the overall total number of Common Eider wintering in the Wadden Sea was quite stable until 2000. Higher variation within the regions and few correlations between different regions show that birds decided opportunistically where to spend the winter in the Wadden Sea.

The Baltic/Wadden Sea population underwent a strong decline in the 1990s (Desholm *et al.*, 2002) which was until recently not seen in the Wadden Sea wintering numbers. Nevertheless, a continued decrease has taken place since 2000 and in January 2002 numbers in the German Wadden Sea were the lowest ever counted. Additionally, in the winter 1999/2000 and subsequent winters large numbers of Common Eiders died due to a lack of profitably harvestable mussels or cockles (Camphuysen *et al.*, 2002; Scheiffarth, 2001), demonstrating that these bird may face a bottleneck when wintering in the Wadden Sea. Therefore, large international concern exists over the state of the Baltic/Wadden Sea Common Eider population (Desholm *et al.*, 2002).

4.4 What do we learn from the current monitoring programs?

Results of the current Wadden Sea monitoring schemes have clearly shown that shellfish-eating birds came under threat in the 1990s. There was a continuous decline in Oystercatcher numbers which led to a decrease in consumption by this species. In the winter 1999/2000 and following years a large mortality of Common Eider was observed, on top of a decline in the Baltic/Wadden Sea population of 36% from 1990 – 2000 (Desholm *et al.*, 2002). Additional evidence for potential shellfish overexploitation is given by strong declines of cockle and *Macoma balthica* feeding Knots (*Calidris canutus*) in areas with high fishing activity (Piersma and Koolhaas, 1997), which can be attributed to long-term indirect effects of cockle dredging (Piersma *et al.*, 2001).

Monitoring data has already been able to show a direct negative relationship between fishing activity and bird numbers when fishing activities have removed almost all intertidal mussel beds, resulting in drastic effects such as distribution shifts and high bird mortalities (Smit *et al.*, 1998, Camphuysen *et al.*, 2002). An earlier study in a situation with a much lower fishing pressure came to the conclusion that Common Eider and mussel fishery did not influence each other (Nehls and Ruth, 1994). The question we have to ask is not whether fishing activity in general has a negative impact, but what level of fishing is sustainable without negative effects on bird populations (*cf.* Stillman *et al.*, 2003). Simple correlations as used in this study are never a valid scientific proof. With monitoring data we can try to build models if we know the underlying processes behind changes in bird numbers (*e.g.* Rappolt *et al.*, 2003). In relation to shellfish fisheries this has been a successful approach for the Oystercatcher population of the Wash, England (Stillman *et al.*, 2003). Current monitoring schemes can serve as a basis on which additional specific studies can then disentangle the relationships between birds and their benthic food resources. While the foraging ecology of the Oystercatcher is well studied, data and results on this topic for Common Eider and Herring Gull are still very basic.

In addition to studies which relate prey choice to prey quality (*e.g.* Nehls, 1995; Laursen and Christensen, in prep.), we have to consider effects which affect the condition and in the long run mortality of the birds, for example, by measuring blood parameters (Verhulst *et al.*, 2004). Such parameters could also serve as an early warning system since it reacts much more quickly to environmental changes than population sizes. These additional studies in combination with models are urgently needed if we want to understand the processes behind changes in bird numbers identified by the current monitoring programs.

As shown in the present study, complex ecological questions cannot be adequately solved by the present monitoring scheme alone. However, it serves as a basis on which accompanying research can resolve specific questions. In the case of shellfish-eating birds, monitoring of birds which can be counted from land delivers valuable data. On the contrary, the data for Common Eider is not sufficient for the entire area during the annual cycle. In particular for the Dutch Wadden Sea only wintering numbers are known.

To resolve questions related to foraging ecology, parameters describing the food stock are indispensable. Unfortunately, monitoring of intertidal mussel beds did not run long enough for the results to be incorporated in this study. At least for the Oystercatcher this would provide a good index of availability of one important prey species. Once this mussel monitoring data series is long enough we should be able to show how far Oystercatcher numbers are influenced by the intertidal mussel stock. In order to cope with environmental changes, birds depend on more than one prey species. For Oystercatcher and Common Eider one additional food source is the cockle. However, apart from in The Netherlands, almost nothing is known about the cockle population in the Wadden Sea. For an explanation of the variation in numbers of shellfish-eating bird species, information about the cockle stocks and cockle population dynamics on a large scale is essential.

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