

High Tide Roosts in the Wadden Sea

A Review of Bird Distribution, Protection Regimes and
Potential Sources of Anthropogenic Disturbance

Colophon

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WADDEN SEA ECOSYSTEM No. 16

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A Review of Bird Distribution, Protection Regimes and
Potential Sources of Anthropogenic Disturbance

A Report of the Wadden Sea Plan Project 34

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In this publication, the report of the Wadden Sea Plan project 34 (WSP § 9.2.1) regarding high tide roosts in the trilateral Wadden Sea is presented. The Wadden Sea Plan, which was adopted at the Governmental Wadden Sea Conference in Stade in 1997, entails besides common policies and measures also projects and actions of the concerned countries for their joint effort to fulfill the already agreed trilateral targets. Regarding birds these targets are 'favorable conditions for migratory and breeding birds: a favorable food availability; a natural breeding success; sufficiently undisturbed roosting and moulting sites; natural flight distances'. Projects on roosting and moulting sites as well as coordinated management for herbivorous species are included in the Wadden Sea Plan. On the basis of project outlines, compiled by the Joint Monitoring Group of Migratory Birds (JMMB), the different investigations were carried out by lead countries with the support of the JMMB.

The aim of the project on roosting sites, which was carried out under the leadership of the Netherlands, was to investigate the status of high tide roosts for migratory waterbirds in the trilateral Wadden Sea in relation to the necessity of undis-

turbed roosting sites for these species. The report consists of a detailed overview of the distribution of waterbirds in the entire Wadden Sea during high tide, and an inventory of protection regimes and potential sources of anthropogenic disturbances for each site. This review on important and potential roosting sites is to be seen as valuable additional information to the regular reports of the Joint Monitoring Program on Migratory Birds in the Wadden Sea in the framework of the Trilateral Monitoring and Assessment Program (TMAG).

The investigations were done, on the one hand, by an overall coordinator of the work, who integrated the results in the report and, on the other hand, by the national coordinators of the monitoring programs of migratory birds in each Wadden Sea country, which are the members of the JMMB. We would like to thank all those who contributed to the surveys and the report, such as the field workers and organizations involved, the authors, in particular Kees Koffijberg, who took care of compiling and writing the report.

Bettina Reineking
Common Wadden Sea Secretariat
May 2003

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Summary

The Wadden Sea ranks among the most important wetlands to migratory waterbirds in the world. Its vast area of intertidal mudflats hosts numerous bird species breeding in the tundra from arctic Canada in the west to northern Siberia in the east. They use the Wadden Sea either as a stop-over site between the arctic breeding areas and the wintering areas in Africa, or stay in the area to winter. Besides, some species gather to moult in late summer. Most birds staying in the Wadden Sea, feed during low tide at intertidal mudflats and congregate in large flocks at communal high tide roosts. Often, these roosts are found at the edges of salt marshes, on sand flats and beaches or, when foreland is lacking, also at dikes and breakwaters in harbours. Some species also roost at inland pastures and arable fields or in wetlands behind the seawall. The attendance of high tide roosts is highly dynamic and depends, e.g., on actual water tables, distance to the nearest feeding areas, the degree of human disturbance and species-specific behaviour. The safeguarding of high tide roosts is one of the most important tools for the conservation and protection of birds in the Wadden Sea and can be achieved by the targets set in the Wadden Sea Plan.

As part of the Wadden Sea Plan and the Stade Declaration of 1997, a special project was launched to investigate the current status of high tide roosts in the Wadden Sea and to present a review of available knowledge of the distribution of waterbirds at high tide roosts, including knowledge concerning the necessity for undisturbed roosting sites. This report presents a detailed overview of distribution of waterbirds in the Wadden Sea during high tide and an inventory of protection regimes and potential sources of anthropogenic disturbance for each site. For this purpose, data from mainly trilateral co-ordinated waterbird counts from the Joint Monitoring of Migratory Birds (JMMB), which are carried out in the framework of the Trilateral Monitoring and Assessment Program (TMAP), between 1990 - 2000 were analysed for species which show tidal movements and depend on high tide roosts. These counts are mainly carried out in the Wadden Sea Cooperation Area, but additionally also include agricultural sites behind the seawall (mainly in Denmark, Lower Saxony and the Netherlands), which belong to the network of roosting sites as well and are especially important during exceptional high tides or for specific terrestrial species

like Brent Goose, Golden Plover and Curlew. Data on site characteristics and potential sources of anthropogenic disturbance were derived from available trilateral data (Quality Status Report) and expert estimates on the level of human activities. Special caution was taken to provide a similar approach in estimating these levels in Denmark, Schleswig-Holstein, Lower Saxony and the Netherlands.

Roosting behaviour in migratory waterbirds is a complex phenomenon. Gathering in large and dense flocks is thought to minimise the risk of predation for individuals by e.g. Peregrine Falcons, but also saves energy when staying close together at the roost. In a dynamic area like the Wadden Sea, actual water tables, distance to the nearest favourable feeding areas, preferred roosting habitat, site-tenacity and social status of the birds all contribute to the actual number of birds and species observed at a high tide roost. As a result, species often use a network of roosting sites. For a species like Red Knot this network might cover an area of 800 km² within a short run of tidal cycles. Apart from these natural factors, the level of anthropogenic disturbance is one of the most important factors determining numbers observed at high tide roosts and puts an extra constraint on the birds' narrow energetic balance and tight time schedule for migration. Case studies in several parts of the Wadden Sea, point out that recreational activities are the most observed sources of disturbance. This is supported by our inventory, which points out that 80% of all roosting sites in the Wadden Sea is subject to some kind of recreational pressure (36% of the roosting sites when considering only moderate to heavy recreational pressure). Moreover, data on phenology show that the seasonal occurrence of some species is affected by moderate and heavy recreation pressure, i.e. birds tend to avoid roosts visited by many people in the summer holiday season.

Hunting is observed at many sites as well (up to 33% of all sites in Denmark, when regarding moderate to heavy hunting pressure). Although hunting on migratory waterbirds has been gradually phased out in the Wadden Sea during the 1990s, hunting on small mammals like Hare is still common practise and also occurs at salt marshes, close to high tide roosts. Other sources of potential anthropogenic disturbance, like civil air traffic, military training activities and wind farms occur at a much smaller scale, although sometimes close to important high tide roosts (e.g. Vliehors

at Vlieland, the Netherlands, which is situated in a military shooting range). In general, it turns out that the largest roosting sites are a result of large intertidal mudflats at close range and low levels (or absence) of human disturbance. This combination is especially found at remote and uninhabited islands, like Süderoogsand, Trischen (both Schleswig-Holstein), Scharhörn (Hamburg), Memmert (Lower Saxony), Griend and Richel (both Netherlands).

The outstanding importance of the Wadden Sea has been acknowledged in several international conventions and directives, such as the Ramsar Convention, the Bonn Convention on Migratory Species and the EC Bird and Habitat Directives. These all have been implemented in the national legislation and the respective protection regimes. When regarding Special Protection Sites of the EC Bird Directive and Ramsar sites, which overlap with most of the national protection regimes, most countries have more than 80% of their high tide roosts located within designated areas (for most species also supporting more than 90% of the birds observed). In the Netherlands and Lower Saxony, this figure is somewhat lower since both countries have a large proportion of inland agricultural areas among their roosting sites, which are subject to limited special protection measures. Only in Lower Saxony, important inland sites outside the trilateral cooperation area have been included in SPA boundaries, whereas in the Netherlands these areas were not taken into account in the last update of SPAs in 2000. Especially species like Brent Goose, Golden Plover and Curlew are known to frequent inland roosts in large numbers. Moreover, inland roosting sites become important for all species during very high water tables, when regular high tide roosts become flooded. In Lower Saxony, Hamburg and Schleswig-Holstein, national protection regimes have been set up by establishing national parks, which include zoning for different human activities. In Denmark and the Netherlands, a similar approach was followed with the introduction of the Nature and Wildlife Reserve and the Key Planning Decision Wadden Sea respectively. However, the actual size of the highest protection zone in these countries is smaller than in Germany. Besides, zoning of recreational activities has not been developed here in detail.

The guiding principle of the trilateral Wadden Sea policy is to "achieve, as far as possible, a natural and sustainable ecosystem in which natural processes proceed in an undisturbed way" (Ministerial Declaration Esbjerg 1991). Three of the four targets on birds, which were agreed upon at the

Leeuwarden Conference in 1994, are related to the impact of human disturbance.

This report shows that, despite extensive protection regimes, disturbance of roosting birds occurs in all parts of the Wadden Sea. Especially outdoor recreation occurs around many roosting sites and its volume, along with conflicts between tourism and nature conservation, is expected to increase in future (Quality Status Report, 1999). Moreover, recreational activities more and more expand to spring and autumn (although still peak during summer holidays in July and August). As a result, potential conflicts between waterbirds attending high tide roosts and recreational activities around these roosts are especially to be expected in May and in July-October. Both are critical periods to birds as they involve pre-migration and pre-breeding fattening and moulting in late summer. In order to reduce this conflict, a spatial and temporal zoning of recreational activities as well as a convincing visitor information system should be further developed.

Besides, more information is needed concerning natural flight distances, which can give feedback in planning public access to areas in the vicinity of roosting sites. For this purpose, also carefully designed experiments should be set up in order to assess the complex relationships between bird numbers and the level of recreational activities. Also it is important to include management of non-waterbird hunting in trilateral protection measures, especially to reduce impact from hunting in salt marshes or inland roosting sites during high tide.

Furthermore, the impact of civil air traffic (including ultra-light aircraft), military training activities and wind farms should be assessed in more detail. Civil air traffic has been largely regulated by trilateral standards now, but severe disturbance is still reported from a number of roosting sites. Military training activities occur only at a few sites, but one of these (Vliehors at Vlieland) is one of the most important high tide roosts in the entire Wadden Sea. Establishing wind farms in the Wadden Sea Conservation Area is forbidden now, but conflicts for roosting birds might arise when planning wind farms in inland areas close to the seawall or in offshore areas close to the Wadden Sea. A more careful selection of sites as well as more detailed studies concerning the impact of wind farms for other species than geese is necessary to reduce possible conflicts here. This can also be achieved by a better formal protection of inland roosting sites, which is lacking especially in the Dutch part of the Wadden Sea.

Sammenfatning

Vadehavet er placeret blandt de mest betydningsfulde vådområder i verden. Det enorme tidevandsområde huser talrige fuglearter som yngler i tundraen fra arktisk Canada i vest til Sibirien i øst. Fuglene bruger Vadehavet enten som en rastepads mellem yngleområderne og overvintringsområderne i Afrika, eller de overvintrer i området. Desuden samles nogle arter i Vadehavet i sensommeren for at fælde deres fjerdragt. De fleste fugle som opholder sig i Vadehavet, søger føde ved lavvande på tidevandsfladerne og samles i store flokke på fælles rastepladser ved højvande. Ofte ligger disse rastepladser på yderkanten af strandengene, på sandflader eller langs kysterne. Nogle arter raster også inde i landet på enge, marker og i vådområder. Benyttelsen af højvandsrastepladserne er meget dynamisk og afhænger f.eks. af den aktuelle vandstand, afstand til nærmeste fødesøgningsområde, graden af menneskelig færdsel og artens adfærd. Sikring af højvandsrastepladser er en af de vigtigste værktøjer i forvaltning og beskyttelse af vandfugle i Vadehavet og er omfattet af de mål som er sat op i Vadehavspanen.

Som en del af Vadehavspanen og Stade Deklarationen fra 1997, blev det vedtaget at iværksætte et projekt for at undersøge den aktuelle status for højvandsrastepladser i Vadehavet. Desuden skulle der udarbejdes en oversigt over den nuværende viden om fordeling af vandfugle på højvandsrastepladser og om nødvendigheden af uforstyrrede rastepladser. Vores rapport giver en detaljeret oversigt over fordelingen af vandfugle i Vadehavet ved højvande og en inventering af beskyttelsesstatus og potentielle typer af menneskelig forstyrrelse på hver lokalitet. Med dette formål, blev data fra de Koordinerede Tællinger af Trækkende Vandfugle (JMMD) indsamlet i perioden 1990-2000 ved hjælp af den Trilaterale Vadehavsovervågning (TMAP), og analyseret for de arter som bevæger sig i forhold til tidevandet og som er afhængige af højvandsrastepladser. Disse optællinger er hovedsagelig indsamlet inden for Samarbejdsområdet for Vadehavet, men omfatter også landbrugsområder bag havdigerne (især i Danmark, Nedersaksen og Holland), som tilhører netværket af rastepladser, og som har en ekstraordinær betydning ved usædvanlige højvande eller for arter som også er tilknyttet det tørre land som knortegås, hjejle og stor regnspeve. Data som vedrører en karakteristisk af lokaliteterne og potentielle kilder til menneskelige forstyrrelser blev

hentet fra tilgængelige trilaterale oplysninger (Quality Status Report) og fra ekspertvurderinger hvad angår niveauet af de menneskelige aktiviteter. Der blev udvist speciel opmærksomhed for at få tilvejebragt en ensartet tilgang til vurdering af disse niveauer i Danmark, Slesvig-Holsten, Nedersaksen og i Holland.

Vandfugles adfærd under rast er et kompleks fænomen. Samling af fugle i store og tætte flokke formodes at mindske risikoen for at blive præderet af f.eks. vandrefalk, men energiforbruget reduceres også når fuglene står tæt sammen på rastepladserne. I et dynamisk område som Vadehavet, bidrager den aktuelle vandstand, afstanden til de nærmeste gode fødesøgningsområder, den foretrukne habitat for rastepladserne, tiltrækning til bestemte lokaliteter og fuglenes sociale status til det aktuelle antal fugle og arter der benytter en given rastepads. Som et resultat af dette, bruger arterne ofte et netværk af flere rastepladser. For en art som islandsk ryle kan dette omfatte et område på 800 km² inden for få tidevandsperioder. Udover disse naturlige faktorer er de menneskelige forstyrrelser de betydeligste faktorer der påvirker antallet af fugle på højvandsrastepladserne. Disse påvirkninger lægger en ekstra pres på fuglene, som ofte har en snæver energi balance og fast tidsskema for det videre trækforløb. Undersøgelser i flere dele af Vadehavet påviser at rekreative aktiviteter er blandt de hyppigst observerede forstyrrelser. Dette understøttes af vores undersøgelse, som påpeger at 29% - 42% af alle rastepladser vurderes at have et moderat til hyppigt rekreativt niveau. Desuden viser data over den tidsmæssige forekomst gennem året at nogle arter er påvirket af rekreativt pres, f.eks. undgår fuglene de rastepladser som besøges af mange mennesker i sommerferiens højsæson.

Jagtaktivitet er observeret på mange lokaliteter (i op til 33% af alle lokaliteter i Danmark foregår der moderat til hyppig jagt). Selvom jagt på trækkende vandfugle er blevet faset ud i Vadehavet igennem 1990'erne, er jagt på små pattedyr som hare stadig en almindelig aktivitet og forekommer også på strandenge nær højvandsrastepladser. Andre årsager til potentielle menneskelige forstyrrelser udgøres af civile flyvemaskiner, militære øvelsesflyvninger og vindmølleparker, som for nogle lokaliteters vedkommende er tæt på vigtige højvandsrastepladser (e.g. Vliehors på Vlieland i Holland, som ligger i et militært skydeom-

råde). Generelt viser det sig, at de største rastepladser opstår som et resultat af flere faktorer bl.a. store tidevandspåvirkede mudderflader inde for en kort afstand og med en lav grad af (eller med fravær af) menneskelig forstyrrelser. Denne kombination er specielt fundet på fjerntliggende øer som Süderoogsand og Trischen (begge i Slesvig-Holsten), Scharhön (Hamborg), Mennert (Nedersachsen), Griend og Richel (begge i Holland).

Vadehavets enestående betydning er blevet anerkendt i adskillige internationale konventioner og direktiver, som Ramsar Konventionen, Bonn Konventionen om Trækkende Arter, i EF Fuglebeskyttelsesdirektivet og i Habitat Direktivet. Disse konventioner er alle blevet indarbejdet i den danske, tyske og hollandske lovgivning og forvaltning. Når man betragter de områder, der er udpeget som EF Fuglebeskyttelsesområder og Ramsamområder, hvoraf de fleste områder overlapper områder der er fredet i henhold til national forvaltning, har landene mere end 80% af deres højvandsrastepladser beliggende inden for beskyttede områder (hvilket omfatter > 90% af de observerede fugle). I Holland og Nedersaksen er disse tal lavere end i de øvrige lande, da de begge har rastepladser i landbrugsområder inde i landet, som kun har en begrænset beskyttelse. Kun i Nedersaksen er betydningsfulde indlandsområder udpeget som EF Fuglebeskyttelsesområder, hvorimod denne type beskyttelse ikke blev taget i betragtning i Holland ved den sidste revision i 2000. Specielt knortegås, hjejle og store regnspeve benytter i vid udstrækning indlandsområder som rastepladser. Desuden er indlandsrastepladser af stor betydning for alle arter af vandfugle under stormflod, hvor de rastepladser der benyttes under normale forhold er oversvømmede. I Nedersaksen og Slesvig-Holsten er der ud over de nævnte beskyttelsesforanstaltninger desuden etableret nationalparker, som omfatter en zonerings af områderne indenfor hvilke forskellige menneskelige aktiviteter kan foregå. I Danmark og Holland er et tilsvarende princip blevet fulgt ved planlægning og etablering af natur- og vildtreservater. Dog er de aktuelle størrelser af de områder der har den største beskyttelse mindre end i Tyskland. Desuden er zonerings af rekreative aktiviteter ikke blevet indarbejdet i detaljer.

Det vejledende princip for den trilaterale politik for Vadehavet er "så vidt mulig at opnå et naturligt og bæredygtigt økosystem, hvor de naturlige processer forløber uforstyrret" (Ministerdeklarationen, Esbjerg 1991). På den efterfølgende Leuwarden Konference i 1994 fokuserer man på betydningen af menneskelige forstyrrelser på fugle-

levet, og tre ud af fire målsætninger for fugle vedrørte dette emne. Vores rapport viser, at til trods for mange regler om beskyttelse af fuglelivet forekommer der forstyrrelser i alle dele af Vadehavet. Specielt friluftsliv forekommer omkring mange rastepladser, og dets omfang forventes at stige i de kommende år og dermed de potentielle muligheder for konflikter mellem turisme og naturbeskyttelse (Quality Status Report 1999). Dertil kommer at aktiviteterne foruden at stige i omfang i selve sommerferieperioden, også stiger om foråret og efteråret. Som et resultat af dette, forventes der at blive et stigende problem for højvandsrastende vandfugle i maj og i juli-oktober. Begge perioder er kritiske for fuglene, da de omfatter tidspunkter i fuglenes årsyklus, hvor de henholdsvis opbygger fedt til forårstrækket eller den forestående ynglesæson og skal gennemføre fjerfældningen. For at reducere disse konflikter yderligere, burde der gennemføres en areal- og tidsmæssig zonerings af de rekreative aktiviteter samt udarbejdes pædagogisk informationsmateriale for besøgende.

Desuden er der brug for mere viden om fuglenes flugtafstande, som kan bidrage til en bedre planlægning af offentlighedens adgang til områder nær fuglenes højvandsrastepladser. Med det formål burde der også udføres detaljerede eksperimenter for at vurdere det komplekse sammenhæng mellem fuglenes antal og niveaue for rekreative aktiviteter. Det er ligeledes vigtigt at undersøge effekten af jagt på andre arter end vandfugle i den trilaterale forvaltning, specielt med henblik på at reducere betydningen af jagt på bl.a. hare på strandene og på rastepladser inde i landet. Desuden burde effekten på rastende vandfugle af civil luftfart og vindmølleparker undersøges yderligere. Civil luftfart er i store træk blevet reguleret af trilaterale aftaler, men der sker stadig betydelige forstyrrelser på flere højvandsrastepladser. Der er kun få områder med militær skydeaktivitet, men nogle af disse ligger nær de mest betydende højvandsrastepladser i hele Vadehavet (bl.a. Vlielands på Vlieland). Det er ikke tilladt at etablere vindmølleparker i Beskyttelsesområdet for Vadehavet. Men konflikter kan opstå, når der rejses vindmøller inde i landet tæt på digerne. Det anbefales derfor, at der udvises mere forsigtighed ved udvælgelse af mølleområder og at det er nødvendigt at udføre flere detaljerede studier på andre arter end gæs for at reducere disse konflikter. Dette mål kan også nås ved en bedre formel beskyttelse af de rastepladser, der ligger inde i landet, hvilket specielt mangler i den Hollandske del af Vadehavet.

Zusammenfassung

Das Wattenmeer zählt für wandernde Wasser- und Watvögel zu den bedeutendsten Feuchtgebieten der Welt. Seine riesigen Wattflächen bieten zahlreichen Vogelarten, die in der Tundra vom arktischen Kanada im Westen bis Nordsibirien im Osten brüten, Lebensraum. Sie nutzen das Wattenmeer entweder als Zwischenrastplatz auf ihrem Weg zwischen den arktischen Brutgebieten und den Überwinterungsgebieten in Afrika oder bleiben, um hier zu überwintern. Außerdem sammeln sich einige Arten im Spätsommer zur Mauser im Wattenmeer. Die meisten Vögel fressen während Niedrigwasser auf den Wattflächen und versammeln sich bei Hochwasser in großen Trupps an Hochwasserrastplätzen. Diese Rastplätze liegen oft an den Rändern der Salzwiesen, auf Sänden und Stränden oder, wo kein Vorland ist, auch an Deichen und Molen in Häfen. Zudem nutzen einige Arten Wiesen und Felder im Binnenland oder Feuchtgebiete hinter dem Deich zur Rast. Die Nutzung der Hochwasserrastplätze ist hoch dynamisch und hängt z. B. von den jeweiligen Wasserständen, der Entfernung zu den nächsten Nahrungsflächen, dem Grad der menschlichen Störung und dem artspezifischen Verhalten ab. Der Schutz von Hochwasserrastplätzen ist eines der wichtigsten Mittel zum Schutz der Vögel im Wattenmeer und wird daher als eigenständiges Ziel im Wattenmeerplan formuliert.

Als Teil des Wattenmeerplanes und der Erklärung von Stade von 1997 wurde ein spezielles Projekt initiiert, mit dem Ziel, eine Bestandsaufnahme der Hochwasserrastplätze im Wattenmeer durchzuführen, eine Übersicht über das vorhandene Wissen zur Verteilung der Vögel auf die Hochwasserrastplätze zu geben und gleichzeitig Erkenntnisse über die Notwendigkeit ungestörter Rastplätze vorzulegen. Der vorliegende Bericht gibt einen detaillierten Überblick über die Verteilung der Rastvögel im Wattenmeer bei Hochwasser und stellt sowohl den jeweiligen Schutzstatus als auch die Quellen möglicher anthropogener Störungen zusammen. Zu diesem Zweck wurden hauptsächlich Daten der trilateral koordinierten Wasser- und Watvogelzählungen (Joint Monitoring Program of Migratory Birds in the Wadden Sea, JMMB), die im Rahmen des Trilateral Monitoring and Assessment Program (TMAP) durchgeführt wurden, aus dem Zeitraum 1990-2000 für Arten analysiert, die sich zeitenabhängig verhalten und auf Hochwasserrastplätze angewiesen sind. Diese Zählun-

gen werden hauptsächlich im Wattenmeer-Kooperationsgebiet durchgeführt, schließen aber auch landwirtschaftliche Flächen hinter dem Deich ein (hauptsächlich in Dänemark, Niedersachsen und den Niederlanden). Diese Flächen gehören ebenfalls zu dem Netz von Rastplätzen und sind besonders wichtig während hoch auflaufender Tiden oder für Arten wie Ringelgans, Goldregenpfeifer und Brachvogel, die Landflächen in höherem Maße zur Nahrungssuche nutzen. Angaben zu den Gebietseigenschaften und den Quellen möglicher anthropogener Störungen stammen aus verfügbaren trilateralen Quellen (Quality Status Report) und beruhen – vor allem bezüglich des Grades menschlicher Aktivitäten – auf den Einschätzungen von Experten. Besondere Sorgfalt wurde darauf verwendet, bei dieser Einschätzung eine in Dänemark, Schleswig-Holstein, Niedersachsen und den Niederlanden vergleichbare Herangehensweise zu gewährleisten.

Das Rastverhalten ist bei den Wasser- und Watvögeln ein komplexes Phänomen. Man nimmt an, dass durch die Ansammlung in großen, dichten Schwärmen für das einzelne Individuum das Risiko sinkt, Räubern, z. B. Wanderfalken, zum Opfer zu fallen, es ist aber auch energetisch günstiger während der Rast dicht zusammen zu stehen. In einem dynamischen Gebiet wie dem Wattenmeer hängt die tatsächliche Anzahl der Vögel und Arten, die an einem Hochwasserrastplatz beobachtet werden können, aber auch von Faktoren wie dem Wasserstand, der Entfernung zum nächsten günstigen Nahrungsgebiet, dem bevorzugten Rasthabitat, der Gebietstreue und dem sozialen Status der Vögel ab. Im Endeffekt nutzen die Arten oft ein ganzes Netz von Rastplätzen. Für eine Art wie den Knutt kann dieses Netz innerhalb weniger Tidenzyklen ein Gebiet von 800 km² umfassen. Abgesehen von diesen natürlichen Faktoren ist der Grad der anthropogenen Störungen einer der bedeutendsten Faktoren für die Zahl der Vögel, die an einem Rastplatz beobachtet werden können und stellt in Phasen mit einer knappen Energiebilanz und einem engen Zeitplan während des Zuges eine zusätzliche Beschränkung für die Vögel dar. Fallstudien in verschiedenen Teilen des Wattenmeeres weisen darauf hin, dass Freizeitaktivitäten zu den häufigsten Störquellen gehören. Dies wird durch unsere Bestandsaufnahme unterstützt, die zeigt, dass für 29% - 42% aller Rastplätze der Freizeitdruck als moderat bis stark

eingeschätzt wird. Darüber hinaus wird anhand von Phänologiedaten deutlich, dass das saisonale Auftreten einiger Arten durch Freizeitaktivitäten beeinflusst wird, d.h. die Vögel meiden in der Sommersaison Rastplätze, die in den Ferien von vielen Menschen besucht werden.

Auch Jagd findet in vielen Zählgebieten statt (bis zu 33% aller Gebiete in Dänemark zeigen moderaten bis schweren Jagddruck). Obwohl in den 1990er die Jagd auf Wasservögel allmählich eingestellt wurde, ist die Jagd auf kleine Säugetiere wie Hasen immer noch üblich und findet auch in den Salzwiesen, nahe der Hochwasserrastplätze statt. Andere Quellen potenzieller anthropogener Störungen, wie ziviler Luftverkehr, militärische Übungen und Windkraftanlagen treten in wesentlich kleinerem Umfang auf, wenn auch bisweilen nahe wichtiger Hochwasserrastplätze (z.B. Vliehors auf Vlieland, Niederlande, das auf einem militärischen Schießplatz liegt). Generell stellt sich heraus, dass die größten Rastplätze dort sind, wo große Wattflächen in der Nähe sind und wenig (oder keine) menschlichen Störungen. Diese Kombination findet sich vor allem auf einigen abgelegenen unbewohnten Inseln wie Süderoog-sand, Trischen (beide Schleswig-Holstein), Scharhörn (Hamburg), Memmert (Niedersachsen), Griend und Richel (beide Niederlande).

Die herausragende Bedeutung des Wattenmeeres wurde in mehreren internationalen Übereinkommen und Richtlinien wie der Ramsar-Konvention, der Bonner Konvention zum Schutz wandernder Arten, der Europäischen Vogelschutz- sowie Fauna-Flora-Habitat-Richtlinie bestätigt. Alle wurden inzwischen in nationales Recht und in entsprechende Schutzbestimmungen umgesetzt. Betrachtet man die Europäischen Vogelschutzgebiete und die Ramsar-Gebiete, die sich mit den meisten der nationalen Schutzgebietskategorien überschneiden, so liegen in den meisten Ländern mehr als 80% der jeweiligen Hochwasserrastplätze innerhalb ausgewiesener Schutzgebiete (die damit zugleich für die meisten Arten >90% der beobachteten Vögel enthalten). In den Niederlanden und Niedersachsen ist diese Zahl etwas niedriger, weil beide Länder einen größeren Anteil binnendeichs gelegener landwirtschaftlicher Flächen am Festland mit berücksichtigt haben, wo weniger Schutzgebiete ausgewiesen sind. Während in Niedersachsen wichtige Binnenlandgebiete als Europäische Vogelschutzgebiete (SPAs) gemeldet wurden, sind diese Gebiete in den Niederlanden bei der letzten Nachmeldung von SPAs 2000 nicht berücksichtigt worden. Besonders von Arten wie Ringelgans, Goldregenpfeifer und Brachvogel ist bekannt, dass sie häufig Binnenland-Rastflächen

in großen Zahlen nutzen. Außerdem sind Binnenland-Rastplätze für alle Arten bei sehr hohen Wasserständen, wenn die regulären Hochwasserrastplätze überflutet werden, wichtig. In Niedersachsen, Hamburg und Schleswig-Holstein wurden mit der Einrichtung von Nationalparks Schutzgebiete etabliert, die eine Zonierung für verschiedene menschliche Aktivitäten einschließen. In Dänemark und den Niederlanden wurde mit der Einführung eines Nature and Wildlife Reserves bzw. der Key Planning Decision Wadden Sea ein ähnlicher Ansatz verfolgt. Allerdings ist die tatsächliche Größe der höchsten Schutzzone in diesen Ländern kleiner als in Deutschland. Davon abgesehen wurde die Zonierung für Freizeitaktivitäten hier nicht im Detail entwickelt.

Der leitende Grundsatz der trilateralen Wattenmeer-Politik ist, „soweit wie möglich ein natürliches und sich selbst erhaltendes Ökosystem, in dem natürliche Prozesse ungestört ablaufen können, zu erreichen“ (Ministererklärung von Esbjerg 1991). Drei der vier Ziele für Vögel, die auf der Konferenz von Leeuwarden vereinbart wurden, betreffen auch den Einfluß menschlicher Störungen. Der vorliegende Bericht zeigt, dass trotz umfassender Schutzbestimmungen Störungen rastender Vögel in allen Teilen des Wattenmeeres auftreten können. Besonders outdoor-Aktivitäten finden an vielen Rastplätzen statt und es kann angenommen werden, dass ihr Ausmaß in Zukunft noch zunimmt – und damit auch die Konflikte zwischen Tourismus und Naturschutz (Quality Status Report, 1999). Zudem weitet sich die Tourismus-Saison zunehmend auf das Frühjahr und den Herbst aus (obwohl der Höhepunkt immer noch in den Sommerferien im Juli und August liegt). Als Ergebnis sind potenzielle Konflikte mit Rastvögeln an Hochwasserrastplätzen besonders im Mai und von Juli bis Oktober zu erwarten. Beides sind kritische Zeitspannen für Vögel, weil sie dann für den Zug und die Brut Fettreserven anlegen müssen und im Spätsommer mausern. Um diesen Konflikt zu verringern, sollte eine zeitliche und räumliche Zonierung der Freizeitaktivitäten ebenso weiter entwickelt werden wie ein überzeugendes Besucher- Informations- und Lenkungssystem.

Insbesondere für die Planung der Wegeführung und für mögliche Zugangsbeschränkungen an Rastplätzen ist es wichtig, mehr Informationen über natürliche Fluchtdistanzen zu erhalten. Zu diesem Zweck sollten auch sorgfältig geplante Experimente durchgeführt werden, mit deren Hilfe die komplexen Beziehungen zwischen Vogelzahlen und Freizeitaktivitäten eingeschätzt werden können. Wichtig ist es ferner, für die Jagd, die nicht das Wasserwild betrifft, trilaterale Manage-

mentmaatregelen zu beschließen, um deren Auswirkungen auf Rastplätze in den Salzwiesen oder im angrenzenden Binnenland während der Hochwasserzeiten zu reduzieren. Weiterhin sollte der Einfluß des zivilen Flugverkehrs (einschließlich ultra-light-Flugzeuge), militärischer Übungsaktivitäten und von Windparks auf die Funktion von Rastplätzen genauer untersucht werden. Obwohl für den zivilen Flugverkehr inzwischen weithin trilaterale Standards gelten, kommt es immer noch zu erheblichen Störungen bei einer Reihe von Rastplätzen. Militärische Übungen finden nur noch in wenigen Gebieten statt, aber Vliehors auf Vlieland ist einer der bedeutendsten Hochwasserrastplätze im gesamten Wattenmeer.

Die Errichtung von Windparks ist im Wattenmeer-Schutzgebiet gegenwärtig verboten, aber mit der Planung von Windparks im Binnenland nahe am Deich oder im Offshore-Bereich nahe am Wattenmeer kann es zu Konflikten mit den Rastvögeln kommen. Um diese Konflikte zu reduzieren, ist es sowohl notwendig, die Standorte der Windparks sorgfältiger auszuwählen, als auch den Einfluß der Windparks für andere Arten als Gänse detaillierter zu untersuchen. Auch ein besserer formaler Schutz von Binnenland-Rastplätzen, der vor allem im niederländischen Teil des Wattenmeeres fehlt, kann zu einer Entschärfung dieses Konflikts beitragen.

Samenvatting

De Waddenzee geniet algemene erkenning als één van de belangrijkste wetlands ter wereld. Z'n grote oppervlakte wadplaten trekt een groot aantal watervogels aan uit een gebied dat zich uitstrekt van arctisch Canada in het westen tot het noorden van Siberië in het oosten. Deze vogels gebruiken de Waddenzee enerzijds als tussenstop tussen hun arctische broedgebieden en de overwinteringsgebieden in tropisch Afrika, anderzijds zijn er soorten die in de Waddenzee de winter doorbrengen. Een aantal soorten vormt bovendien ruiconcentraties in de nazomer. De meeste vogels zoeken tijdens eb op de wadplaten naar voedsel. Tijdens hoogwater komen ze bijeen op gemeenschappelijke hoogwatervluchtplaatsen. Dit zijn plaatsen die doorgaans tijdens een normale vloed niet worden overspoeld, zoals randen van kwelders, hooggelegen zandplaten, stranden en soms ook aan de buitenzijde van de dijken. Sommige soorten overtijnen bij voorkeur binnendijks, zowel op cultuurland als in binnendijkse wetlands. Het gebruik van hoogwatervluchtplaatsen is in hoge mate dynamisch. De aantallen kunnen sterk variëren onder invloed van vloedhoogte, afstand tot naburige voedselgebieden, de mate van menselijke verstoring and soort-specifieke factoren. Gezien de sterke concentratie van vogels op hoog-

watervluchtplaatsen is bescherming en behoud van deze plekken, zoals ook verwoord in het Trilaterale Waddenzee Plan, van groot belang.

In het kader van het Trilaterale Waddenzee Plan, voortgekomen uit de Verklaring van Stade in 1997, is een speciaal project opgezet om de ligging, het gebruik en de potentiële bedreigingen van hoogwatervluchtplaatsen in de Waddenzee in kaart te brengen. Tevens moest onderzocht worden in welke mate vogels gevoelig zijn voor menselijke verstoring en welk belang het minimaliseren van verstoring rond hoogwatervluchtplaatsen heeft. In dit rapport wordt een overzicht gegeven van de verspreiding van watervogels op hoogwatervluchtplaatsen, de eventuele beschermde status die de hoogwatervluchtplaatsen genieten en de potentiële menselijke verstoring in de directe omgeving. De gegevens die hiervoor werden gebruikt waren voornamelijk afkomstig van de watervogeltellingen zoals die gedurende 1990-2000 in het kader van het trilaterale meetnet van de Joint Monitoring of Migratory Birds (JMMB) werden verzameld. Dit programma maakt onderdeel uit van het Trilateral Monitoring and Assessment Programme (TMAP) van Denemarken, Duitsland en Nederland. Alleen die soorten werden uitgewerkt, waarvan bekend is dat ze getij-

debewegingen vertonen. Bij de telgebieden die werden geselecteerd gaat het zowel om gebieden die in het trilaterale Beschermingsgebied liggen als gebieden daarbuiten. Die laatste hebben vooral betrekking op binnendijks gelegen graslanden en akkers (vooral in Denemarken, Nedersaksen en Nederland), die eveneens onderdeel uitmaken van het netwerk van hoogwatervluchtplaatsen (vooral tijdens stormvloed) en voor sommige soorten (o.a. Goudplevier en Wulp) soms worden geprefereerd boven buitendijkse hoogwatervluchtplaatsen. De gegevens over habitat, beschermde status en potentiële menselijke verstoring werden afgeleid uit trilateraal beschikbare gegevens (Quality Status Report) en de expertise van nationale specialisten voor wat betreft de verstoringsgegevens. Om te bewerkstelligen dat de beoordeling hiervan op een uniforme manier gebeurde werden tijdens twee bijeenkomsten de gegevens van de landen onderling vergeleken en bediscussieerd.

Het gebruik van hoogwatervluchtplaatsen is een complex fenomeen. Het concentreren in grote, dichte groepen wordt algemeen gezien als anti-predatie gedrag, bijvoorbeeld vanwege de alom aanwezige Slechtvalken in de omgeving. Daarnaast is er vooral in de winter een energetisch voordeel om als groep dicht opeengepakt te overtijden. In een dynamisch gebied als de Waddenzee spelen daarnaast ook de actuele waterstanden, de afstand tot favoriete voedselgebieden, ligging van geprefereerd habitat om te overtijden, alsmede de plaatstrouw en sociale dominante van de vogels zelf een rol in de benutting van hoogwatervluchtplaatsen. Het gevolg hiervan is dat veel soorten afhankelijk zijn van een netwerk van gebieden. Bij een soort als de Kanoet kan dat leiden tot het gebruik van 800 km² wad (en dus verschillende hoogwatervluchtplaatsen) binnen slechts enkele getijdencycli. Naast natuurlijke factoren speelt ook het risico van menselijke verstoring een bepalende rol voor het aantal overtijdende vogels, die bovendien nog eens extra druk legt op de strakke trekschema's en energiehuishouding van de vogels. Diverse studies hebben laten zien dat vooral recreatie in potentie veel verstoring kan veroorzaken in de Waddenzee. Dit wordt bevestigd door de analyse in dit rapport. Van alle hoogwatervluchtplaatsen in de Waddenzee, wordt 80% door recreanten bezocht; 36% van de hoogwatervluchtplaatsen staat zelfs bloot aan een matige tot zware recreatiedruk. Gegevens over het seizoensvoorkomen van een aantal soorten wijzen er bovendien op dat hoogwatervluchtplaatsen worden gemeden bij een matige tot zware recreatiedruk. Dit vindt vooral plaats in de nazomer, tijdens het vakantie seizoen.

Jacht vindt eveneens in veel gebieden plaats, in Denemarken is zelfs op 33% van de hoogwatervluchtplaatsen sprake van een matige tot zware jachtdruk. Ofschoon jacht op trekkende watervogels in de Waddenzee inmiddels grotendeels aan banden is gelegd, vindt er nog steeds op veel plaatsen, waaronder op de kwelders en in nabijheid van hoogwatervluchtplaatsen, jacht op hazen en konijnen plaats. Andere bronnen van verstoring, zoals civiele luchtvaart, militaire oefeningen en plaatsing van windparken opereren op kleinere schaal, ofschoon soms in de directe nabijheid van belangrijke hoogwatervluchtplaatsen (bijv. de Vliehors op Vlieland, dat midden in een militair schietterrein ligt). In het algemeen kan gesteld worden dat grote en belangrijke hoogwatervluchtplaatsen vooral in die gebieden liggen waar in de directe omgeving een grote oppervlakte aan wad beschikbaar is, en waar de kans op verstoring minimaal is. Deze combinatie vinden we vooral bij afgelegen (onbewoonde) zandplaten, zoals Süderoogsand en Trischen (beide Sleeswijk-Holstein), Scharhörn (Hamburg), Memmert (Nedersaksen) en Griend en Richel in Nederland.

Het internationale belang van de Waddenzee wordt onderkend in diverse internationale verdragen, zoals de Ramsar Conventie, de Conventie van Bonn en de Europese Vogel- en Habitatrichtlijn. Deze verdragen zijn alle geïmplementeerd in nationale wetgeving. In de Waddenzee ligt in de meeste landen meer dan 80% van de hoogwatervluchtplaatsen in gebied dat valt onder de Speciale Beschermingszones van de EU-Vogelrichtlijn (Vogelrichtlijngebieden) of binnen de begrenzing van Ramsargebieden (beide overlappen vrijwel geheel). Het gaat hierbij gemiddeld om ongeveer 90% van de aanwezige vogelaantallen. In Nederland en Nedersaksen is het aandeel beschermde gebieden lager. Beide landen hebben een groot aantal binnendijkse hoogwatervluchtplaatsen, die in het algemeen geen beschermde status genieten. Alleen in Nedersaksen zijn belangrijke binnendijkse rustgebieden opgenomen in de begrenzing van Speciale Beschermingszones; in Nederland zijn deze gebieden niet in beschouwing genomen bij de nieuwe aanwijzingen in 2000. Vooral soorten als Rotgans, Goudplevier en Wulp komen in belangrijke aantallen op binnendijkse hoogwatervluchtplaatsen voor. Bovendien zijn deze rustplaatsen van belang tijdens stormvloed, als de reguliere hoogwatervluchtplaatsen overspoeld worden. In Nedersaksen, Hamburg en Sleeswijk-Holstein zijn in het kader van nationale natuurbescherming nationale parken opgericht. Deze kennen een zonering van strikte natuurge-

bieden tot gebieden met vrije toegang en mogelijkheden voor recreatie. In Denemarken (Nature and Wildlife Reserve) en Nederland (PKB Waddenzee, Natuurbeschermingswet) bestaan vergelijkbare systemen. De oppervlakte aan gebieden met een strikte bescherming is er in de regel echter kleiner dan in Duitsland. Bovendien is er een minder sterk ontwikkeld systeem van beheer van recreatie.

Het grondbeginsel voor het trilaterale Waddenzeebeleid is het - voor zover mogelijk - verwezenlijken van een natuurlijk en duurzaam Wadden Zee ecosysteem, waar natuurlijke processen ongestoord doorgang kunnen vinden (Verklaring van Esbjerg, 1991). Drie van de vier doelstellingen die met betrekking tot vogels zijn geformuleerd op de Leeuwarden Conferentie, gaan over versturende activiteiten van mensen en de effecten daarvan op het voorkomen van vogels. Dit rapport laat zien dat ondanks een hoge mate van formele bescherming, veel hoogwatervluchtplaatsen in de gehele Waddenzee blootstaan aan druk van menselijke activiteiten. Vooral recreatie komt op de meeste plaatsen voor, zij het met verschillende intensiteit. Algemeen wordt verwacht dat zowel de intensiteit van recreatie als de spreiding door het jaar heen in de komende jaren toeneemt (Quality Status Report, 1999). Weliswaar pieken deze nog steeds tijdens de zomervakantie in juli en augustus, meer en meer vinden ook activiteiten plaats in voorjaar en najaar. Potentiële conflicten met overtijdende vogels zullen dan ook verder toenemen, niet alleen in de nazomer, maar vooral ook in de voor vogels belangrijke opvet-perioden in Mei en Juli-Oktober, als veel vogels zich moeten voorbereiden op het naderende broedseizoen (mei) of de trek van en naar de broedgebieden (zowel mei als juli-oktober). Bovendien maakt een aantal soorten in de nazomer de rui door in de Waddenzee, en is dan extra kwetsbaar. Een mogelijke oplossing van dit conflict is het verder ontwikkelen van een goed functionerende zonering van natuur en recreatie, alsmede het opzetten van een overtuigend informatiesysteem voor bezoekers.

Daarnaast is extra informatie nodig over de afstanden dat vogels gevoelig zijn voor verstoring. Alleen met gegevens over natuurlijke opvliegafstanden kan een goed werkende zonering worden ontwikkeld van gebieden met een voornamelijk recreatieve bestemming en gebieden met een vooral natuurlijke bestemming. Hiervoor is het tevens noodzakelijk experimentele studies uit te voeren, waarin de relatie tussen het vogelbezoek aan hoogwatervluchtplaatsen en menselijke activiteiten in de omgeving onder gecontroleerde omstandigheden wordt onderzocht. Wat betreft jacht is het van belang dat niet alleen de jacht op trekkende watervogels, maar ook bijvoorbeeld hazenjacht op de kwelders en direct aangrenzende binnendijkse gebieden in trilaterale afspraken in beschouwing wordt genomen; dit om verstoring tijdens vloed te zoveel mogelijk te reduceren.

Verder zouden effecten van civiele luchtvaart (incl. ULV's), militaire oefeningen en windparken meer in detail in kaart moeten worden gebracht. Civile luchtvaart is grotendeels gereguleerd in trilaterale afspraken, maar nog steeds wordt in een aantal gebieden veel verstoring gerapporteerd. Militaire activiteiten vinden nog slechts op kleine schaal plaats, maar in het geval van de Vliehors op Vlieland wel in de directe nabijheid van één van de belangrijkste hoogwatervluchtplaatsen in de gehele Waddenzee. Het opzetten van windparken is inmiddels verboden in het trilaterale Beschermingsgebied. Potentiële conflicten leveren hier vooral de binnendijkse windturbines direct in de nabijheid van de zeewering. Tot nu toe is vooral het effect van windparken op ganzen onderzocht, maar het verdient aanbeveling dergelijke studies ook uit te voeren voor andere soorten. Conflict-vermijding tussen hoogwatervluchtplaatsen en binnendijks geplande windparken kan daarnaast worden bewerkstelligd door belangrijke binnendijkse hoogwatervluchtplaatsen onder te brengen in formele beschermingszones, vooral voor wat betreft het Nederlandse deel van de Waddenzee waar vrijwel geen van de binnendijkse hoogwatervluchtplaatsen een beschermde status heeft.

1. Introduction and Background

1.1 Introduction

The Wadden Sea ranks among the most important wetlands to migratory waterbirds in the world. Its vast area of intertidal mudflats hosts numerous bird species breeding in the tundra from arctic Canada in the west to northern Siberia in the east. They use the Wadden Sea either to refuel en route between the arctic breeding areas and the wintering areas in Africa, or to stay during winter. Besides, some species gather to moult during summer. Meltøfte et al. (1994) showed that in the 1980s some 10-12 million waterbirds utilised the area during their annual life cycle, and at least 52 geographically distinct populations of 41 species were present in numbers exceeding the 1% thresholds of the Ramsar Convention. Of several species, numbers observed in the Wadden Sea even involve nearly the entire population.

Most birds using the Wadden Sea feed during low tide at the intertidal mudflats, and gather at communal high tide roosts during high tide. Often, these roosts are found at the edges of salt marshes, on sand flats and beaches or, when foreland is lacking, also at dikes and breakwaters in harbours. Some species also use inland pastures and arable fields, or wetlands behind the seawall as high tide roosts, especially during spring tides or after prolonged stormy weather, when regular high tide roosts become flooded. On the other hand, neap tides and easterly winds might not flood all mudflats and causes several birds to remain in the intertidal area during high tide. Moreover, use of high tide roosts often varies between species and largely depends on the distance to the nearest favourable feeding areas and the potential risk of disturbance (van de Kam et al. 1999). As these conditions vary, the use of high tide roosts can be often dynamic, both between species and within a species, e.g. in the course of a year and at different sites.

The prime importance of the Wadden Sea to (water)birds is recognised in many official documents and international conventions and directives, on national scale as well as within the trilateral cooperation between Denmark, Germany and the Netherlands. Large areas have been designated as Wetlands of International Importance under the Ramsar Convention and have been (will be) implemented in the Natura 2000 network of the EC-Bird Directive and EC-Habitat Directive (Special Protection Areas (SPAs) and Special Areas of Conservation (SACs), respectively). Besides, protection regimes such as Nature and Wildlife Reserve, National Park and Nature Reserve (e.g. de Jong et al. 1999), have been established at a national level.

Despite these protective measures, there is a continuous, and increasing pressure from human exploitation, like fisheries, oil- and gas drilling and recreational activities (CWSS 1991, de Jong et al. 1999). Especially outdoor activities like wind surfing, tidal flat walking and recreational boating have increased considerably in the past decades and nowadays occur during a more prolonged period in the year (de Jong et al. 1999). Although a direct link between human activities and the occurrence of birds at high tide roosts is often difficult to assess, human activities impose a potential threat, especially when regarding the large concentration of birds in the Wadden Sea and their dependence on safe roosting sites during high tide. Migratory birds generally have to cope with narrow physiological and energetic balances and are often bound to fixed time-schedules (e.g. Piersma 1994). Hence, they heavily depend on the resources they find at their stop-over sites en route between breeding- and wintering areas, and any serious disturbance or other human impact may easily disturb the precarious balance the birds are subject to. Eventually winter survival and breeding success, and thus population levels, might be affected as well (e.g. Madsen & Fox 1995).

1.2 Wadden Sea Plan and Project 34

In the framework of the trilateral Wadden Sea Cooperation of Denmark, Germany and the Netherlands the ministerial declarations are the results of consecutive Danish-German-Dutch Governmental Conferences on the Protection of the Wadden Sea. At the 8th Trilateral Governmental Conference on the Protection of the Wadden Sea (TGC) in 1997 in Stade, Germany, the responsible Ministers agreed to adopt the Wadden Sea Plan (WSP), entailing the common policies, measures, projects and actions of the Wadden Sea countries Denmark, Germany and the Netherlands, for their joint efforts to fulfil the already agreed targets during the 7th TGC in Leeuwarden (1994). Concerning birds, these targets include favourable conditions for migratory and breeding birds, a natural breeding success, sufficiently large undisturbed roosting and moulting areas and natural flight distances (see § 6 and Annex 1 of the Minister Declaration of TGC Leeuwarden, 1994). As mentioned above, waterbirds in the Wadden Sea highly depend on safe and undisturbed high tide roosts. Therefore, among others, a special WSP project was agreed upon during the Stade Conference. This so-called WSP Project 34 aimed at "An investigation of all important and potential roosting sites along the coastline of each country, in conjunction with an evaluation of available knowledge on the necessity of undisturbed roosting sites, in order to investigate the possibilities for certain undisturbed roosting sites" (Wadden Sea Plan, § 9.2.1, 1997).

The area for which the Wadden Sea Plan and the WSP project 34 is valid is the Trilateral Wadden Sea Cooperation Area, in short, the Wadden Sea Area, from Den Helder, the Netherlands to Blåvandshuk, Denmark delimited by the three nautical miles offshore and the main seal walls or, where the sea walls are absent, the spring-high-tide-water line, and in the rivers, the brackish-water limit including Ramsar and/or EC Bird Directive areas designated inland.

The Dutch Ministry of Agriculture, Nature Management and Fisheries took the lead for the implementation of this WSP project and initiated the investigation of the current status of high tide roosts for migratory waterbirds in the Wadden Sea. On behalf of this Ministry, the 'Expertise Centrum LNV' commissioned SOVON Vogelonderzoek Nederland, to carry out this investigation, in close collaboration with the national co-ordinators of the Joint Monitoring Program for Migratory Birds (JMMB) in the Netherlands, Germany and Denmark.

These include the 'Staatliche Vogelschutzwarte' at the 'Niedersächsisches Landesamt für Ökologie (NLÖ)' in Lower Saxony, the 'WWF-Projektbüro Wattenmeer' and 'Landesamt für den Nationalpark Schleswig-Holsteinisches Wattenmeer' in Schleswig-Holstein and the National Environmental Research Institute (NERI) in Denmark. Data for this project were mainly derived from the high tide waterbird counts in the Wadden Sea (see below).

1.3 Aims and project outline

The aims of the Wadden Sea Plan project 34 have been formulated as:

- to investigate the current status of high tide roosts in the Wadden Sea;
- to present a general review of anthropogenic disturbance of birds at high tide roosts;
- to identify protection status and potential anthropogenic threats and disturbance to high tide roosts in the Wadden Sea.

In order to assess the current status and use of high tide roosts in the Wadden Sea, data collected during systematic waterbird counts in Denmark, Germany and the Netherlands between 1980-2000 were analysed. These counts include all high tide roosts along the Wadden Sea shores and nearby inland areas but do not cover major offshore concentrations of seaducks and, e.g., offshore moulting Shelduck. Since 1992, they are carried out within the framework of the Joint Monitoring Program for Migratory Birds, as part of the Trilateral Monitoring and Assessment Program (TMAP), the joint-monitoring project of the Trilateral Wadden Sea Cooperation. The migratory bird monitoring program is conducted under responsibility of the Joint Monitoring Group of Migratory Birds (JMMB), in which the national co-ordinators of the waterbird surveys in the Wadden Sea are represented. The Common Wadden Sea Secretariat (CWSS) in Wilhelmshaven acts as the secretariat for the group. The monitoring program includes two synchronised international counts and frequent (12-24 annually) counts at spring tide sites (Rösner 1993, Rösner et al. 1994, Poot et al. 1996). Moreover, additional national counts have been included in this report (e.g. Koffijberg et al. 1999, Günther & Rösner 2000, de Boer et al. 2001, Rasmussen 2001, Kleefstra et al. 2002). The counts have been analysed on the smallest level of counting units (see Fig. 2.1).

With this report on WSP project 34, it is the first time that the distribution of waterbirds in

the Wadden Sea is presented at such a detailed level. The regular trilateral reports so far presented aggregated data for larger regions (Rösner et al. 1994, Poot et al. 1996) or densities for intertidal areas where high tide roosts were supposed to belong to (Melfo et al. 1994). The combination of bird data and information concerning human activities at site-level will assess the current network of roosting sites and provide the necessary output for the investigation of the possibilities for undisturbed roosting sites in the Wadden Sea.

Protection status and potential sources of anthropogenic disturbance were derived from data available at the Wadden Sea Secretariat (de Jong et al. 1999) and an inquiry among the national co-ordinators of the joint monitoring program. The latter included an expert-judgement estimate for the intensity of human activities, such as farming, hunting and recreational activities. It should be stressed here that these data do not represent true assessments (which are lacking) but are mere-

ly based on qualifications from local experts and only allow a global inventory of potential threats to waterbirds at high tide roosts.

A large part of this report consists of a detailed description of the 602 sites in the Wadden Sea for which data were analysed. This includes an overview of protection status, habitats and human exploitation/potential threats (chapter 4), as well as separate species accounts for species which are known to frequent high tide roosts regularly (chapter 5). The selection of species as well as field methods and data processing are outlined in chapter 2. Chapter 3 provides a review of the functional aspects of the use of high tide roosts by birds. Moreover, it aims at presenting a general review of the interactions between occurrence of birds and the intensity of human activities, by summarising results of research on the impact of anthropogenic disturbance, made in several parts of the Wadden Sea so far. A general discussion and major conclusions are included in chapter 6.

2.1 Introduction

The large numbers of waterbirds in the Wadden Sea have attracted ornithologists for decades. Various parts of the area were surveyed as early as the 1930s, but with increasing effort especially from the 1960s onwards (see Smit & Wolff 1981 and Meltofte et al. 1994 for a review). The first synchronous and internationally co-ordinated counts were carried out in September 1973 and January/April 1975. Results of these counts have been included in the first review of distribution and numbers of waterbirds in the Wadden Sea by Smit & Wolff (1981). Furthermore, Meltofte et al. (1994) summarised trilateral co-ordinated counts in 1980-91. The main aim of these counts was to assess the importance of the Wadden Sea for protection and conservation purposes.

In order to feed the growing need for monitoring data, joint trilateral monitoring programmes were initiated within the Trilateral Wadden Sea Cooperation. For this purpose, the Joint Monitoring Program for Breeding Birds in the Wadden Sea started in 1989/90, followed by the Joint Monitoring Group of Migratory Birds in the Wadden Sea in 1992. Both include delegates from Denmark, Schleswig-Holstein, Lower Saxony and the Netherlands, and operate within the framework of the Trilateral Monitoring and Assessment Program (TMAP). The counts carried out within this international framework include two annual synchronous, complete counts of all species, frequent spring tide counts of all species at a sample of sites and species-specific counts of geese and sea-ducks (Rösner 1993). They aim at: (1) estimating the total population size of waterbirds in the Wadden Sea; (2) monitoring changes in numbers of waterbirds present in the Wadden Sea and (3) assessing numbers of waterbirds using the Wadden Sea over the year. As part of this international co-operation, international reviews have been published in 1994 (Rösner et al. 1994) and 1996 (Poot et al. 1996). The next regular report is sched-

uled for 2003 (Blew et al. in prep.). These reports aim to present baseline data on numbers, distribution and phenology. Moreover, they are important feedback to the numerous (partly volunteer) observers.

2.2 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. Counting dates are chosen around spring tide, and usually fieldwork concentrates in a narrow time window around a chosen counting date, preferably avoiding adverse observation conditions like fog and heavy rain. Observers mostly operate from dikes or dunes, using high magnifying (20-60x) telescopes to determine species and numbers. In larger salt marshes, also small trips to the shoreline are made in order to get a better view of the roosting flocks. Small uninhabited islands are counted from boats, or are reached by foot during low tide. In Denmark, part of the data presented here refer to aerial surveys. For this purpose, a standardised flight route is conducted covering all parts of the Danish Wadden Sea, including open water (e.g. Laursen et al. 1997).

Areas behind the seawall are surveyed in all countries, although coverage varies considerably between the countries. Often they only include the area situated adjacent to the dike, e.g. various coastal polder areas (pastures as well as arable land) in the Netherlands, Lower Saxony and Denmark. In Schleswig-Holstein, inland sites mainly represent recently reclaimed areas where wetlands have remained. However, species such as Curlew, which are known to frequent inland pastures up to 15 km from the dike (Zwarts 1996, Gloe 1998) are only partly covered during the counts as they often feed too far inland to be spotted from the seawall. The same also applies to Golden Plover and Oystercatcher, although often these species

2.3 Analysis of bird counts

2.3.1 Counting units and high tide roosts

The aim of this report is to present a review of species and numbers of waterbirds observed at high tide roosts in the Wadden Sea. During waterbird counts, however, high tide roosts are often not treated separately. In fact, counting units covering only one roost are rare, and only occur at the smaller islands or in very small-scale areas. Usually, the smallest units comprise 3 to 5 km coastline (see Fig. 2.1), and may include several high tide roosts at short range from each other. Apart from this, it is very difficult to speak of a discrete high tide roost (Fig. 2.2). Particularly at salt marshes, single roost are very difficult to separate as many flocks stay along the entire tide mark and often displace with changing water tables and when being disturbed. High tide roosts with such a frequent interchange of birds thus merely consist of one 'ecological unit', which generally are covered well within one single counting unit. We therefore assume, that the scale of the smallest counting units, as used in this re-

port, is suitable to assess the used high tide roosts.

Since Schleswig-Holstein, Lower Saxony and the Netherlands had their counting units based in a Geographical Information System (GIS), we can also give some information on the actual size of the counting units (Fig. 2.3). Both Lower Saxony and the Netherlands have a similar pattern, with most counting units being 200-500 ha, and only a few larger than 1000 ha. In Schleswig-Holstein, the range in size is roughly similar, but the majority of counting units is much smaller and often does not exceed 100 ha. Although the network of counting units in Schleswig-Holstein is indeed generally smaller than in the other two countries, the emphasis on areas of 1-100 ha is also a result of the treatment in GIS. Counting units along dikes without foreland were not designed as areas but as a linear transect, which allows no calculation of size. Similar differences in treatment might also occur in the other countries, frustrating direct comparison. Hence, we assume that slight differences in numbers resulting from varying size of counting units do occur, especially in Schleswig-Holstein, where smaller numbers per high tide roost might be due to the rather small size of the counting units.

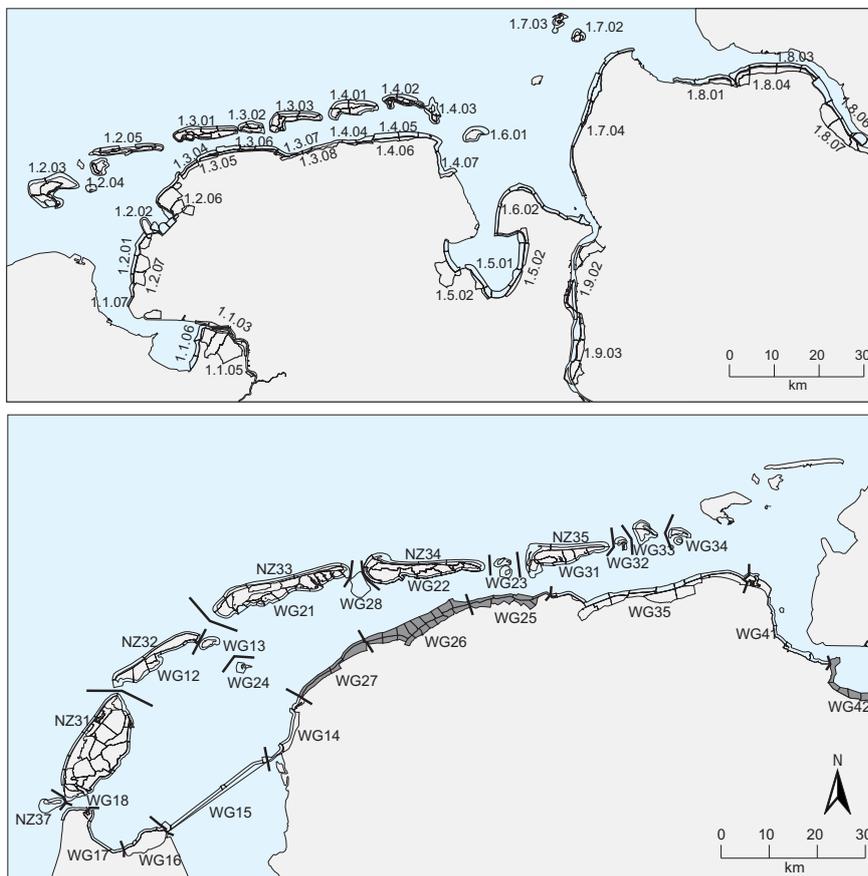
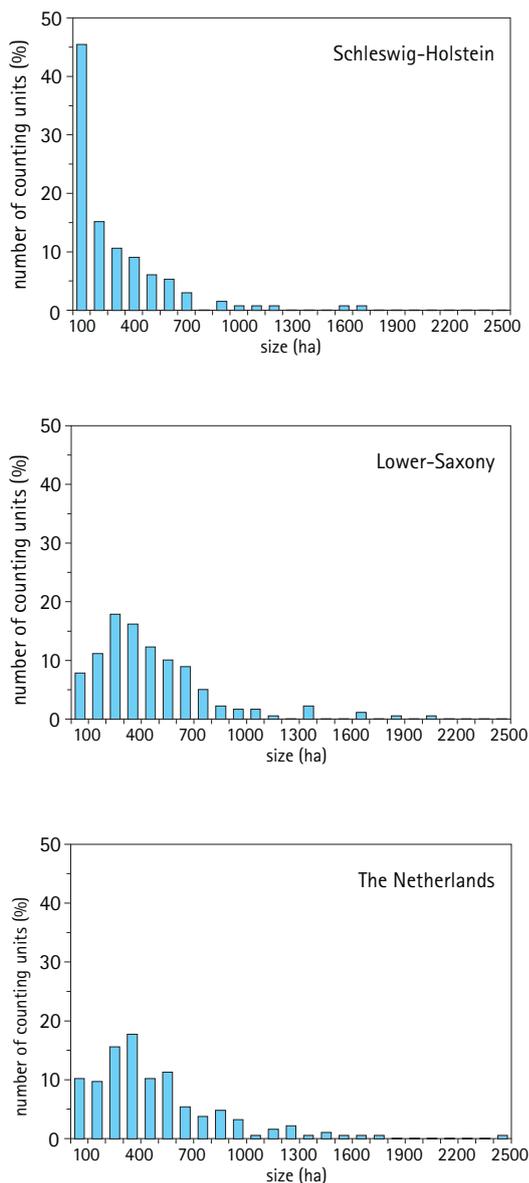


Figure 2.2:
 Example of a counting unit (WG35, Noordpolder, the Netherlands) with several high tide roosts situated at the lower parts of the salt marsh (data hypothetical, but based on field experience). Each species shows different roosting behaviour, some gathering in dense flocks, others (Dunlin, Oystercatcher) remaining at the available mudflats at the edge of the salt marsh where feeding is still possible just before and after high tide. Many species occur in species-specific roosts, but mixing also occurs (in this example one large loosely concentrated flock of Grey Plover, Dunlin and Bar-tailed Godwit). Examples of species-specific behaviour are the Grey Plovers roosting on the wooden barriers of the sedimentation works and an inland roosting flock of Curlews. When disturbed, or with rising water tables, many flocks take flight and relocate. Hence, it is difficult to speak of one discrete roost. When interchange frequently occurs within one area, which is generally well covered by most of the counting units, we can speak of one 'ecological unit'. In this report, such units have been considered one roosting site.



Figure 2.3:
 Size (in ha) of counting units in Schleswig-Holstein, Lower Saxony and the Netherlands. Shown is the number of sites within 1-100, 101-200 ha, and so on.



2.3.2 Data selection

Counts

In order to provide actual data, only counts from 1990 onwards have been processed. Data from the most recent years (2000/2001) were often not yet available, but have been included where possible until the first half of 2001 (Tab. 2.1). They include all available counts, i.e. synchronous complete counts, spring tide counts as well as aerial surveys in Denmark and refer to both trilateral coordinated counts and counts carried out for national purposes. Therefore the actual number of counts varies considerably between the countries. In general, Schleswig-Holstein achieves the best coverage, mainly as a result of the high number of sites where frequent spring tide counts are carried out, and which cover about 60% of the water-bird population staying there (Günther & Rösner 2000). In Lower Saxony, several areas are counted in a monthly rhythm. Besides, results of spring tide counts at selected sites are -for most species- fairly representative for the entire part the Wadden Sea in Lower Saxony. Coverage in the Netherlands and Denmark is not that good and many sites lack monthly coverage each year. Also, the selection of spring tide sites is considered less representative, at least in the Netherlands (van Roomen et al. 2002). However, both in the Netherlands and in Denmark, the important migration periods when large numbers are present are covered well when taking a period of several years, as done in this study. Figure 2.4 indicates general coverage, expressed by the quality code delivered with the monthly data (see chapter 2.3.3).

Country	No. census units	Period	Co-ordinator
The Netherlands	182	Jul 1995-Jun 2000	Sovon Vogelonderzoek Nederland, Beek-Ubbergen
Lower Saxony	180	Jul 1990-Jun 2000	Staatliche Vogelschutzwarte, Nieders. Landesamt für Ökologie, Hannover
Schleswig-Holstein	149	Jan 1993-Dec 2000	WWF-Projektbüro Wattenmeer, Husum
Denmark	91	Jan 1990-Jan 2000	National Environmental Research Institute, Kalø

Table 2.1:
Summary of data used for
this report.

Species

As this review primarily deals with high tide roosts, only those species have been included which are known to use high tide roosts, and feed at the intertidal mudflats during low tide. These include nearly all waders (except Lapwing, Ruff and Common Snipe, which mainly feed at salt marshes), but also a number of goose and duck species, such as Brent Geese and Wigeon, which partly depend on *Zostera* and *Enteromorpha* beds at the intertidal mudflats and show tidal movements. Cormorant is included as well. Although this species shows less pronounced tidal movements, it does use common roosts during high tide. For this reason also gulls have been included (except Lesser Black-backed Gull, which is mainly a marine species). Barnacle Goose and several ducks are not covered in this report, as they mainly rely on salt marsh vegetation and do not show tidal movements. Terns have been excluded as well, partly as they do not concentrate at high tide roosts (although they gather at communal night roosts) and

feed both during low tide and high tide. Moreover, they were not included in the counts in all countries.

Thus, the birds selected here for the presentation of data on the use of high tide roost consist of a mixed group of species which only roost during high tide (most waders), birds which use the roost regardless of the tidal cycle (e.g. Cormorants) and birds which use the high tide roost to continue feeding during high tide (e.g. Brent Geese, Wigeon). Table 2.2 lists all species considered, including information on the geographical population it belongs to and the population size (after Rose & Scott 1997). Also, maximum numbers observed in the Wadden Sea between 1995-2000 are given (after de Jong et al. 1999).

Sites

Selection of counting units followed the sites depicted in figure 2.1. The delineation of these sites are in line with the so-called Wadden Sea Cooperation Area and include estuaries of Eider, Elbe, Weser and Ems (see e.g. de Jong et al. 1999). How-

Code	Species		Flyway	Max. numbers Wadden Sea	Flyway Population
720	Cormorant	<i>Phalacrocorax carbo</i>	NW Europe	4,660	120,000
1680	Brent Goose	<i>Branta bernicla</i>	W Siberia	116,000	250,000
1730	Shelduck	<i>Tadorna tadorna</i>	NW Europe	254,000	250,000
1790	Wigeon	<i>Anas penelope</i>	NW Europe	320,000	750,000
4500	Oystercatcher	<i>Haematopus ostralegus</i>	E Atlantic	739,000	874,000
4560	Avocet	<i>Recurvirostra avosetta</i>	E Atlantic	44,600	67,000
4700	Ringed Plover	<i>Charadrius hiaticula</i>	E Atlantic	14,100	242,500
4770	Kentish Plover	<i>Charadrius alexandrinus</i>	E Atlantic	812	67,000
4850	Golden Plover	<i>Pluvialis apricaria</i>	NW Europe	168,000	1,800,000
4860	Grey Plover	<i>Pluvialis squatarola</i>	E Atlantic	140,000	168,000
4960	Red Knot	<i>Calidris canutus</i>	E Atlantic	433,000	861,000
4970	Sanderling	<i>Calidris alba</i>	E Atlantic	20,200	123,000
5090	Curlew Sandpiper	<i>Calidris ferruginea</i>	E Atlantic	6,680	436,000
5120	Dunlin	<i>Calidris alpina</i>	E Atlantic	1,200,000	1,394,000
5340	Bar-tailed Godwit	<i>Limosa lapponica</i>	E Atlantic	341,000	822,000
5380	Whimbrel	<i>Numenius phaeopus</i>	E Atlantic	1,330	69,000
5410	Curlew	<i>Numenius arquata</i>	E Atlantic	227,000	348,000
5450	Spotted Redshank	<i>Tringa erythropus</i>	E Atlantic	15,200	75,000
5460	Redshank	<i>Tringa totanus</i>	E Atlantic	59,600	286,000
5480	Greenshank	<i>Tringa nebularia</i>	E Atlantic	15,000	50,000
5610	Turnstone	<i>Arenaria interpres</i>	E Atlantic	8,120	99,000
5820	Black-headed Gull	<i>Larus ridibundus</i>	NW Europe	242,000	>5,000,000
5900	Common Gull	<i>Larus canus</i>	NW Europe	103,000	1,600,000
5920	Herring Gull	<i>Larus argentatus</i>	NW Europe	328,000	1,400,000
6000	Great Black-backed Gull	<i>Larus marinus</i>	E Atlantic	15,400	480,000

Table 2.2:
List of waterbird species
covered by this report.
Selection of species is
based on the use of high
tide roosts, i.e. only those
species are included which
show movements between
high roosts and feeding
sites at the intertidal
mudflats. Flyway and
population sizes according
to Rose & Scott (1997).
Also shown are maximum
numbers observed in the
Wadden Sea (after de Jong
et al. 1999).

ever, a few important extensions were made to cover all important roosting sites. Since some species heavily depend on inland sites, all available inland counting units behind the seawall (which are not always included in the Wadden Sea Cooperation Area, especially when referring to agricultural areas) were taken into account as well. These include coastal polders in the Netherlands, Lower Saxony and inland marshes in Denmark and inland wetlands in Schleswig-Holstein and Denmark (see also chapter 2.3.1). Terrestrial inland areas in Schleswig-Holstein are less well-covered since agricultural areas are usually not taken into account here. Since the delimitation of counting units is somewhat different between the countries, caution is sometimes necessary when interpreting results presented in this report (which is indicated in the text where appropriate).

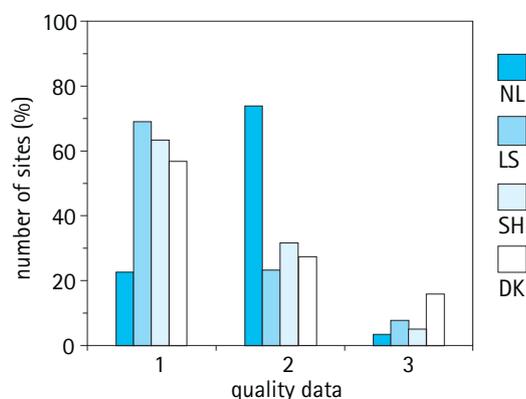
2.3.3 Data processing and coverage

In a first step, all data were processed at a national scale. For each counting unit, a monthly mean number of birds was calculated. These were added over the year and divided by 12 to arrive at an annual mean number of birds in a counting unit (i.e. roosting site). This annual mean number of birds reflects the distribution of a species over the roosting sites. Only for some species which only occur on migration during a short period, this figure might underestimate the use of a site since the annual mean will be small as a result of many months with no or minor occurrence. Missing data for counting units which had no coverage at all in

certain months were imputed (except for a few areas holding only very small numbers, which were left out in the analysis). In the Netherlands, Lower Saxony and Denmark, imputing was carried out using Uindex (Underhill & Prys-Jones 1994). This technique provides models for filling in missing data according to population trends, seasonal pattern and site information. For this report, missing data were imputed according to the pattern in phenology in the same country. In Schleswig-Holstein, missing values were calculated after interpolation, roughly following the same approach as the other countries. Except for Denmark, the number of missing values was actually rather small, referring to <10% of all sites. Most months had sufficient coverage (> 5 counts in a period of 5 to 10 years; Fig. 2.4).

For Denmark, a special treatment was necessary as the data consisted of ground-based counts as well as aerial surveys. For many larger species, the aerial surveys provided the best results, for many smaller species the ground-based counts (cf. Meltofte et al. 1994). In cases where both ground-based and aerial counts were available for the same month, always the maximum figure was used (yielded by one of these counts), assuming that this was achieved according to the best of either methods. As aerial surveys were not used in other countries some bias will probably be included in the Danish data when comparing them with the other countries. However, leaving aerial surveys out, would have resulted in a (too) large number of missing counts.

Figure 2.4:
Number of counts used to calculate the annual mean number of birds. Shown is the number of sites (in %) with (1) >5 counts in a certain month; (2) 1-4 counts or (3) no counts at all. When no counts were available, imputing was used to estimate the numbers (see text for details).



2.4 Analysis of site information

2.4.1 Introduction

Along with a database with bird numbers at high tide roosts, also an inventory of habitat characteristics, protection regime status and potential sources of anthropogenic disturbance was set up in order to assess the status and potential threats of high tide roosts in the Wadden Sea. Safe and undisturbed roosts are generally considered as one of the main prerequisites birds set to use a site regularly as high tide roost (see chapter 3). However, contrary to bird numbers, true assessments to quantify, e.g., the level of anthropogenic disturbance at a roosting site are very limited. In the 1980s, assessments of recreational activities have been made in Denmark, in conjunction with the aerial bird counts (Laursen et al. 1997). More often, data on recreational activities refer to the number of overnight stays or the number of boats in marinas (de Jong et al. 1999), which do not indicate the level of potential disturbance at a specific roosting site.

Therefore, a site-based inventory (including those sites where information on bird numbers was available) was set up by the national co-ordinators of the waterbird counts in order to review the status of high tide roosts by a combination of existing data on, e.g., protection regimes (de Jong et al. 1999) and expert information on the estimated level of anthropogenic activities around the roosting sites. The latter included farming, hunting, oil and gas exploitation, military training, civil aviation, wind farms and recreational activities. It must be stressed here that the experts' estimates refer to the *potential* sources of disturbance, and do not refer to *observed* sources and level of disturbance. We have worked on the assumption that a higher intensity of anthropogenic activities at a site also reflects a higher potential risk of disturbance.

The inventory of site information was carried out by Karsten Laursen and Lars-Maltha Rasmussen (Denmark), Klaus Günther & Kai Eskildsen (Schleswig-Holstein), Peter Südbeck, Petra Potel & Jörn Bunje (Lower Saxony), Klaus Janke (Hamburg) and Ben Koks & Kees Koffijberg (the Netherlands). Two meetings were organised (May 2002 and August 2002) to discuss the first results and provide a similar approach in judgement between the different countries. Data of habitat characteristics, protective status, oil- and gas exploration and military training were checked with avail-

able data at the Common Wadden Sea Secretariat in Wilhelmshaven (cf. de Jong et al. 1999). All data refer to the period 1995-2000, unless otherwise stated. Protection regimes represent the situation in 2000.

2.4.2 Data and classification

Habitat

Each high tide roost was assigned to a habitat type. In most cases, the size of the roost was small enough to allow a simple classification. In cases where more than one habitat type occurred, the dominant type was chosen. Habitat types were:

- MA - salt marsh
- SA - sand flat
- BE - beach
- DU - dunes
- DI - dike or breakwater (mole or jetty, mainly in harbours)
- AI - artificial structure, e.g. platforms
- IN - inland polder, mainly with natural habitat
- IA - inland polder, mainly with agricultural habitat (pastures as well as arable land)

Protection regimes

They consist of both international and national treaties and legislation. In many cases these cover the entire roosting site (classified as 1 - >70% protected), but in case only part of the site is protected this is classified as 2 - 30-70% protected or 3 - <30% protected. Moreover, some sites have yet only been proposed, and have not been officially designated. These have been listed as code 5 - 'proposed'. Protection regimes have been designated at site level by the national co-ordinator, based on the national delineation of protected areas (see also de Jong et al. 1999 for a general review).

International protection regimes

An important part of the Wadden Sea has been designated as a Ramsar site. These designation are according to the Ramsar Convention (set up in 1971) and applies to wetlands of international importance which support regularly 20,000 or more waterbirds or more than 1% of geographically distinct waterbird populations (Ramsar Convention Bureau 1984).

Furthermore, Special Protection Areas (SPAs) have been designated. These areas are protected according to the EC Bird Directive (directive 79/409/EEC) and aim at protection and conservation of migratory European bird species (especially those included in annex 1, i.e. threatened and

endangered species). In addition, the EC Habitat Directive (directive 92/43/EEC) has been set up for the conservation of areas of special interest (so-called Special Areas of Conservation, SACs). Together, SPAs and SACs constitute the Natura 2000 network. In this report, only SPAs have been included since the Habitat Directive implicates the nearly the same protection status. Moreover, the Habitat Directive has not fully been implemented yet.

National protection regimes

Besides international designations and the trilateral Wadden Sea Cooperation, all countries in the Wadden Sea have also developed national protection and management regimes in their concerned part of the Wadden Sea. The vast majority of the German Wadden Sea is covered by the national parks of Schleswig-Holstein, Hamburg and Lower Saxony respectively. These include a segregation in zones 1-3, e.g. areas with highest protection status and closed to public except for existing roads and tracks, areas with limited access in the breeding season from 1 April to 31 July and areas which are primarily designated for recreational use and which have only limited restrictions regarding use. The delineation of national parks and regulations differ between Schleswig-Holstein, Hamburg and Lower Saxony (see chapter 4.3 for details). The recent extension of the National Park 'Niedersächsisches Wattenmeer' (according to federal law Nds. GVBI S.443, 31 July 2001), concerning the Dollard and some offshore areas in July 2001 has not been taken into account in this report since analysis of bird data includes counts up to the first half of 2001 (see chapter 2.3.2). Nevertheless, the topical borders of the area are given in Fig. 4.2, 4.4 and 4.6. In Denmark and the Netherlands, similar national protection regimes have been established by the 'Nature and Wildlife Reserve' and the 'Key Planning Decision Wadden Sea' respectively. These include a zonation for different activities as well (see 4.3 for details). Additionally, e.g. besides the already mentioned national parks, nature reserves have been established in all countries. Regulations in these reserves vary from limited access to access only outside the breeding bird season. In this report, only nature reserves have been taken into account which are situated outside the national parks (Germany), the Nature and Wildlife Reserve (Denmark) and outside the area which is subject to the 'Key Planning Decision Wadden Sea' (Netherlands).

Potential anthropogenic disturbance

Seven categories of human activities have been categorised which pose a potential threat to birds roosting at high tide roosts. Note that the codes refer to estimated intensity by the national experts, and do *not* represent true assessments, nor *direct observations of disturbance* (see chapter 2.4.1). Intensity of human activities has been coded 0 - 'none', 1 - 'low', 2 - 'moderate' and 3 - 'heavy' according to expert judgement of the national co-ordinators. In some cases, criteria for distance have been used (for wind farms) since possible impact on flocks of roosting birds will decrease with distance. For this purpose, distance has been arbitrarily set at 1 km. This matches with the ranges given in references concerning the actual impact of wind farms (see chapter 3.4.2).

Farming

Categories according to estimated intensity of agricultural use. Sites with a dominant agricultural management, e.g. arable fields and improved grassland in inland areas, have been given code 3 - 'heavy'. At salt marshes light to heavy grazing (e.g. summer polders) have been classified as code 1 - 'low' and 2 - 'moderate' respectively.

Hunting

Categories according to estimated hunting pressure, ranging from sites with only occasional hunting (code 1 - 'low') to sites with regular and frequent hunting throughout the main part of the year, i.e. in the open season in autumn and winter (code 3 - 'heavy'). Frequent hunting, but occurring only in a limited part of the open season has been coded as 2 - 'moderate'.

Oil- and gas exploitation

Potential disturbance here has been regarded as the human activities around an exploitation site (e.g. reconstruction works and supply of people and cargo) and direct impact by, e.g., intensive light during night.

Military training

Military training area, airfield or helicopter pad. Only regularly used military training areas and shooting ranges have been classified according to code 3 - 'heavy'. Accidentally used areas and specially designated low flying zones of aircraft have been included as well (code 1 - 'low' or 2 - 'moderate', depending on use).

Civil aviation

Applying especially to high tide roosts in direct proximity of an airport and landing strip with frequent landings and take-offs and low flying

planes. These have all been classified 3 - 'heavy'. Other possible disturbances include frequent low flying aircraft, e.g. for exercising low-altitude flights or sight-seeing at specific sites (e.g. Westerhever Lighthouse). These have been coded as 1 - 'low' or 2 - 'moderate', depending on observed or supposed frequency. Frequently used flight routes, causing regularly potential disturbance have been classified as 2 - 'moderate'.

Wind farm

Applying to roosts within 1 km distance of wind energy turbines. Here, codes 1-3 represent the different types of wind turbines, i.e. single turbines (coded as 1), lines of turbines (2) and wind farms (3).

Recreational activities

Among farming and hunting, recreational activities are difficult to quantify since they cover a wide array of activities, vary throughout the year (emphasis on summer) and lack any source of numerical information. They include beach visitors, day-hiking, tidal flat walking (also from anchored boats), kite-flying, recreational boating, wind surfing, sea-kayaking, angling and bait-digging. Some of these activities are very much concentrated at specific sites (e.g. beach visitors at North Sea beaches) and are often associated with good public access of a site. Sites which are highly frequented by people, throughout main parts of the year have been classified as 3 - 'heavy', Sites with occasional high visitor numbers as 2 - 'moderate' and sites with limited number of people, particularly during weekends, as 1 - 'low'.

Accessibility

In addition to recreational activities, also accessibility of roosting sites has been assessed. Accessibility was measured by taking the human access to the roost or its surroundings, regarded from the birds at the roost. We assume the level of potential disturbance to be related to the access of the roosting site (see chapter 4.4).

Codes are:

- 0 - no public access,
- 1 - accessible only at the borders of the roost, by bike or by foot (no direct access to the roost itself),
- 2 - accessible by bike or by foot (direct access to the roost),
- 3 - accessible by car.

3. Functional Aspects of High Tide Roosts

3.1 Introduction

Why do birds roost?

The vast intertidal mudflats of the Wadden Sea, host an estimated 10-12 million of birds, originating from a large area between the Canadian and Siberian arctic (Melfofoe et al. 1994). During their visit to the Wadden Sea, these birds are tightly bound to the tidal rhythm and feed during low tide on the intertidal mudflats and, apart from seaducks and moulting Shelduck, gather at communal high tide roosts when the mudflats become flooded by the rising water. Often, these roosts are situated at open and exposed sites with only sparse vegetation. At such sites, like salt marshes and sand flats, potential danger can be spotted more easily. The communal flocking behaviour is mainly thought to be a response to the risk of predation by raptors (e.g. Ydenberg & Prins 1984, Myers 1984, Cresswell 1994). By gathering in large flocks, the risk of predation is minimised for individuals. In the Wadden Sea, highest predation risk is probably imposed by Peregrine Falcon, which winters in growing numbers in the area (Bijlsma *et al.* 2001). An alternative reason for birds to congregate at high tide roosts is to save thermostatic

costs. When staying sheltered, either close together or hidden in vegetation, energy expenditure is considerably reduced (Wiersma et al. 1993, Wiersma & Piersma 1994). Thirdly, high tide roosts might function as information centres, providing the birds present information on the situation of optimal feeding sites (Ward & Zahavi 1973), although evidence for this is often regarded circumstantial (e.g. Ydenberg & Prins 1984).

Numbers and behaviour

In general, the number of birds found at high tide roosts depends on the area of intertidal mudflats surrounding the roost (Ens et al. 1993; Fig. 3.1). However, the birds do not distribute themselves evenly over the mudflats, but generally follow peak abundance in available food stocks (e.g. Zwarts 1996), and therefore favour different kinds of mudflat type. Moreover, they try to minimise the distance between feeding site and roosting site (Zwarts 1976). An analysis of wader counts in the Dutch part of the Wadden Sea in the 1970s and 1980s revealed that, e.g., Turnstone and Bar-tailed Godwit preferred sandy sediments, whereas species like Dunlin and Curlew favoured muddy substrates (Ens et al. 1993) Especially the occurrence

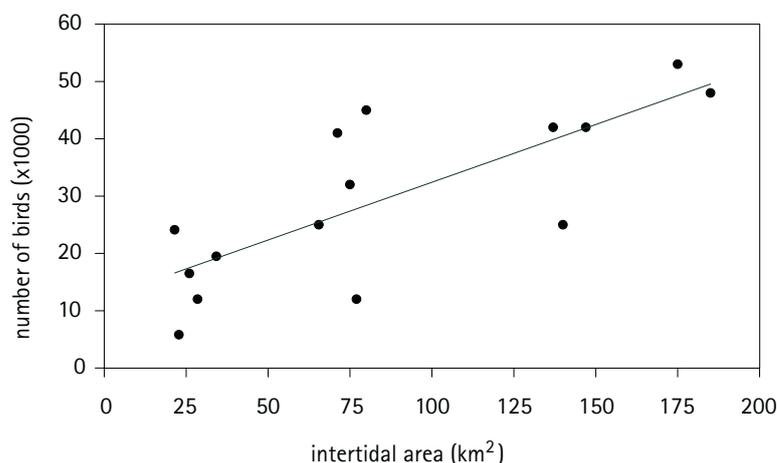


Figure 3.1: Relationship between numbers of roosting waders and size of the surrounding intertidal area in 15 census areas in the Dutch part of the Wadden Sea, derived from counts between 1966-1984 (after Ens et al. 1993).

of Oystercatcher and Curlew was also strongly associated with the distribution of mussel beds. Since food preferences differ among species, the species-composition at high tide roosts varies from site to site.

Particularly Oystercatcher and Curlew are known to stay for prolonged periods at high tide roosts (i.e. arrive early and depart late after high tide) as their feeding opportunities are most profitable in the lowest parts of the intertidal area, which are the first to become flooded (Ens et al. 1996, Zwarts et al. 1996). Smaller species such as Dunlin and Redshank depend more on food resources found at the higher parts of the intertidal area and therefore often arrive later at the roost and leave sooner as the first mudflats become available again. Most birds which attend high tide roosts can be observed resting or preening (see e.g. Exo et al. 1999) and often gather with individuals of the same species or closely related species (e.g. *calidris* and *tringa* species). Especially species like Redshank and Greenshank are also often found in ponds, gullies and channels in salt marshes, which still provide a suitable feeding habitat during high tide. Attendance of high tide roosts and activity thus might reflect species-specific differences and also varies throughout the year since in spring most species spend more time feeding to gain body reserves for spring migration and breeding (van de Kam et al. 1999). Besides, Swennen (1984) has shown for Oystercatcher that birds of different social hierarchy do not distribute themselves evenly over a roost, but that larger roosts are generally visited by dominant birds (e.g. adults), and are situated closer to favourable feeding areas.

3.2 Dynamics in the use of high tide roosts

Long-term research in the Wash, England, showed that many wintering waders (especially adults) showed a high degree of site-fidelity and were recaptured several times in the same site within the area (Rehfishch et al. 1996). A similar site-fidelity was also found in Dunlin and Curlew in Schleswig-Holstein (Rösner 1990, Oberbrodhave & Stock 1996), Oystercatcher in the Netherlands (e.g. Swennen 1984) and is also well known for geese (e.g. Ganter 1994). However, the use of specific high tide roosts in highly dynamic areas like the Wadden Sea is subject to a large variance in environmental conditions. Apart from human disturbance effects (see chapter 3.4), numbers at high tide roosts highly depend on the actual water ta-

bles, which are influenced by the tidal cycle (spring tide versus neap tide) as well as the prevailing wind.

Wind from NW drives more water into the Wadden Sea, and causes often a 50-100 cm higher water table during high tide, even more when combined with spring tide (van de Kam et al. 1999). Such a situation results in larger concentrations of roosting birds, as many of the regular sites are not available due to flooding. When salt marshes become flooded, many birds are observed to roost inland, behind the seawall, especially on pastures or ploughed/sparsely vegetated arable land. Contrastingly, concentration of birds at high tide roosts is lower during days with strong wind from E (especially >5 Beaufort, and more pronounced when coinciding with neap tide), when parts of the intertidal area are not flooded at all, and remain available for feeding birds during high tide. This pattern of high and low water tables is even more pronounced in funnel-shaped areas like Dollard and Jadebusen which have a much higher tidal amplitude. Hence, environmental conditions cause considerable differences in the actual site-use and the concentration of birds at individual roosts.

Besides, several studies have also shown, that some species are rather opportunistic when choosing a particular site to roost. Zwarts (1996) showed examples of Greenshank and Spotted Redshank, which commuted considerable distances (Greenshank even 13 km) to a high tide roost at Schiermonnikoog, but easily deserted their regular site when a new site became available along the mainland coast. Kersten et al. (1997) and Exo et al. (1999) even showed changes of high tide roosts within one day, i.e. birds staying at the islands during nocturnal high tide and attending roosts along the mainland coast during diurnal high tide. Frequent interchanges between roosts at mainland coast and islands are probably common practice for many species, but detailed information is lacking for most sites.

Site attendance thus is a complex phenomenon, depending on natural conditions (water tables, available food biomass within close range of a roosting site), individual strategies (site-tenacity), social hierarchy, distance to feeding sites and -above all- the rate of disturbance and risk of predation and the species-specific responses to these factors. With respect to conservation and safeguarding of roosting sites, it is therefore important that one cannot speak of separated high tide roosts, but merely of a network of roosts which is used under different conditions. This also implicates that changes in conditions at one site might easily affect other sites as well.

3.3 Preferred habitats

High tide roosts are often characterised by sparsely vegetated sites, although differences exist between species. Since all high tide roosts have been assigned to a habitat type (see chapter 2.4.2), we can reveal some of the species-specific preferences from the data analysed for this report. For this purpose, the annual mean number of birds at a roost throughout the year was aggregated for each habitat type (Fig. 3.2). Obviously, most birds stay in salt marshes during high tide. This habitat represents an extensive area along most Wadden Sea coastlines, which usually remains available during most high tides. Sanderling, Herring Gull, Greater Black-backed Gull and Red Knot, on the other hand, clearly prefer sandy habitats, either beaches or sand flats. This preference is closely related to the preferred feeding habitat (e.g. beaches for Sanderling and gulls), but also expresses the preference for a large-flocking species as Red Knot to choose remote and undisturbed sand flats for roosting. Other species found in considerable numbers at sand flats and beaches are Bar-tailed Godwit, Kentish Plover, Cormorant, Turnstone and Common Gull. Also these species are known to favour sandy feeding areas (Bar-tailed Godwit, Kentish Plover, Turnstone; Ens et al. 1993) or undisturbed sites (Cormorant).

Besides, large numbers are sometimes found at inland sites behind the dikes. These include more or less natural wetlands as well as agricultural fields in coastal polders (see chapter 4.2). Golden Plover is the only species which shows a clear preference for inland sites, followed by Spotted Redshank, Wigeon, Common Gull, Brent Goose, Whimbrel, Greenshank and Black-headed Gull. Some of these species are associated with certain agriculture practices (Golden Plover, Brent Goose, Wigeon, Common Gull, Whimbrel), others mainly with wetlands (Spotted Redshank, Greenshank). Some of the species roosting at inland sites are also known to feed extensively there, e.g. herbivores like Brent Goose and Wigeon, which feed at improved grassland or crops, and several waders which feed on earthworms and insect larvae (mainly in grassland) and other invertebrates (mainly in wetlands). Inland feeding at grassland is also frequently reported for other species like Oystercatcher and Bar-tailed Godwit (van de Kam et al. 1999). Moreover, some species which are known to commute frequently between intertidal mudflats and agricultural habitats inland are underrepresented in our data, e.g. Curlew which might feed at inland sites up to 10-15 km from the Wadden Sea (Zwarts 1996, Gloe 1998) and which are not included in the Wadden Sea counts. Curlew, Whimbrel and gulls are also known to feed

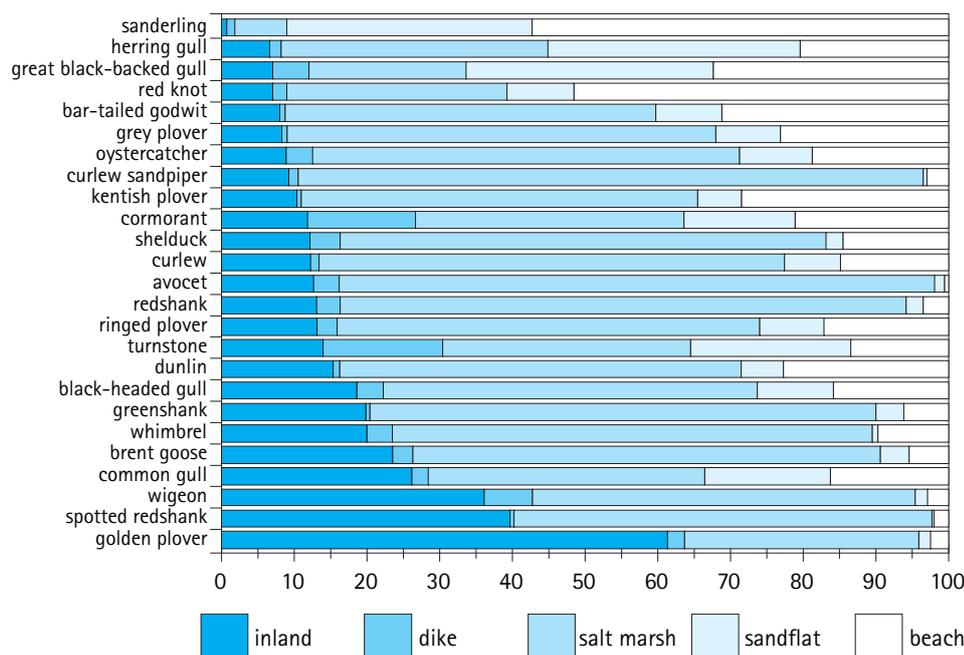


Figure 3.2: Habitat use of different species at high tide roosts. Shown is the sum of all annual means, aggregated for inland roosting sites (agricultural areas/wetlands), anthropogenic structures (dikes, breakwaters in e.g. harbours, platforms), salt marshes, beaches (beaches/dunes) and sand flats (for country-specific data see species accounts, chapter 5).

on inland pastures during daytime and use salt marshes to roost during night (e.g. Meeuwsen & van Scharenburg 1988).

Only two species occur frequently at dikes, breakwaters and other artificial structures, as demonstrated by Turnstone (which also feeds extensively at artificial 'rocky' habitats) and Cormorant. The latter roosts at dikes and breakwaters at harbours, as well as on various platforms.

3.4 Disturbance at high tide roosts

3.4.1 Theoretical review

The degree of anthropogenic disturbance is generally considered as one of the main triggers determining the number of birds at a high tide roost (Davidson & Rothwell 1993a, Cayford 1993). Human activities involved, usually consist of a wide array of activities, ranging from wind surfing and sailing to recreational walking, tidal flat walking, biking, bait-digging and low flying planes or helicopters. However, the term disturbance is rather ambiguous, since it is difficult to assess how individual birds and populations are affected in terms of fitness and survival (Cayford 1993, Stock et al. 1994). Following Stock et al. (1994), we use the term disturbance here only to describe responses of birds to various sources of anthropogenic activities. In general, disturbance increases the energy expenditure of individual birds, since they take flight and have to relocate themselves (Belanger & Bedard 1990, Cayford 1993). Depending on species, time of the year and available food resources, birds might be well able to compensate for the effect of disturbance, or even get used to a cer-

tain degree of human activities (habituation; Davidson & Rothwell 1993b, Cayford 1993, Madsen 1995, Spaans et al. 1996). High levels of disturbance may, however, finally result in loss of a roosting site, as has been demonstrated by Mitchell et al. (1988) for the Dee Estuary in England. Impact on population levels is often more difficult to prove. Population dynamics are affected by various other factors and it has proven very difficult to isolate key variables determining population levels and thus quantifying the precise impact of disturbance.

It is most likely that disturbance has a pronounced impact during critical periods of the annual life cycle, when birds face difficulties in meeting their daily energy requirements, particularly during cold weather periods, during accumulation of body reserves for migration and breeding or during moult in late summer (Davidson & Rothwell 1993b, Madsen 1995). Only few studies have been able to prove a direct impact on population level so far. As Madsen (1995) demonstrated for the Svalbard-breeding Pink-footed Geese, disturbance might easily lead to a reduction in pre-breeding condition and hence reproduction rate. These birds had a significant lower breeding success when they were scared at their stop-over site in northern Norway, disabling them to accumulate enough body reserves for migration and breeding.

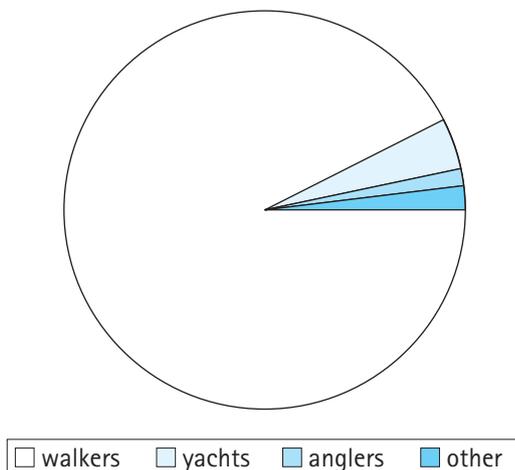
When regarding the prime importance of the Wadden Sea to migratory and wintering waterbirds and the narrow balances they are faced with concerning their daily energy requirements for winter survival and accumulation of body reserves, disturbance might well put an extra constraint on the birds present in the Wadden Sea. This becomes even more obvious when other constraints are taking into account as well, e.g. changes in food resources as a result of mussel fisheries. Managing anthropogenic activities in the Wadden Sea, as proposed in the Wadden Sea Plan, is therefore an important tool to safeguard the existing roosting sites.

3.4.2 Disturbance in the Wadden Sea

Sources of disturbance

In the Wadden Sea, most human disturbance has to be expected from recreational outdoor activities. In the past decades, these have experienced a considerable increase and occur in a greater part of the year now and will probably further increase in future years (CWSS 1991, Spaans et al. 1996, Knoke & Stock 1994, de Jong et al. 1999). A sur-

Figure 3.3:
Human outdoor activities
observed during monthly
aerial surveys in the Danish
Wadden Sea in 1980-1995
(after Laursen et al. 1997).



vey in the Danish Wadden Sea in 1980-95, revealed that 91% of human activities observed during the aerial bird counts referred to walkers, and only 2-4% to, e.g., angling, sailing (incl. wind surfers) and hunting (Laursen et al. 1997; Fig. 3.3). Human activities were very much concentrated at the North Sea beaches (Rømø and Fanø) in July and August, but elsewhere the peak in the summer tourist season was less pronounced and outdoor activities were also observed frequently from April to October, although still peaking in July (Fig. 3.4).

Studies in Schleswig-Holstein, Lower Saxony and the Netherlands point at a similar pattern. Also here, most human activities occur between April and October, peaking during summer holidays in July and August (Frank 1992, Spaans et al. 1996, Knoke & Stock 1994, Smit 2000). Disturbance stimuli observed, involved mainly (up to 51%) recreational activities. In particular (beach) walking, tidal flat walking, biking and kite-flying are among the most frequent sources of disturbance recorded (Smit & Visser 1993, Mock & Rösner 1994, Spaans et al. 1996, Stock et al. 1995, Schothorst & Veenendaal 1999, Smit 2000). Other important sources of disturbance referred to aeroplanes (including military jets) and helicopters (see Table 3.1 for a review). Apart from human disturbance, also natural disturbances occur. In a special study concerning disturbance of water-birds in the Dutch Wadden Sea, birds accounted even for 80% of all disturbance observed (Spaans et al. 1996). These involved often raptors, raptor-like birds like Grey Heron and crows and Great Black-backed Gulls, which are regarded as predators and often cause flocks to take flight. In a special study at Margrethe Kog in Denmark, Laursen & Rasmussen (2002) also showed that different sources of disturbance might operate additively. They recorded significantly more disturbance at a high tide roost with a mixed-species flock (expressed by the time that the birds spend flying) when both more people were present on a nearby path and more raptors (e.g. Peregrine Falcon and Merlin) were observed around the roost. When raptors were absent, the behaviour of the birds was not affected at all by people walking on the path.

Impact of outdoor recreation

The response of birds to anthropogenic disturbance varies greatly among species and often differs from site to site and time of the day. Often it is also difficult to assess since birds might respond to a single source of disturbance and relocate them-

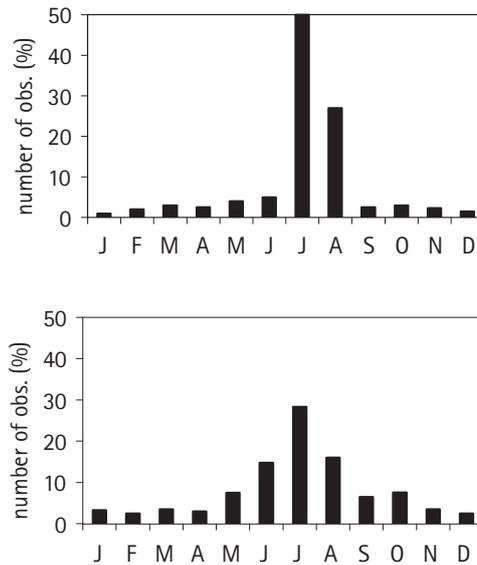
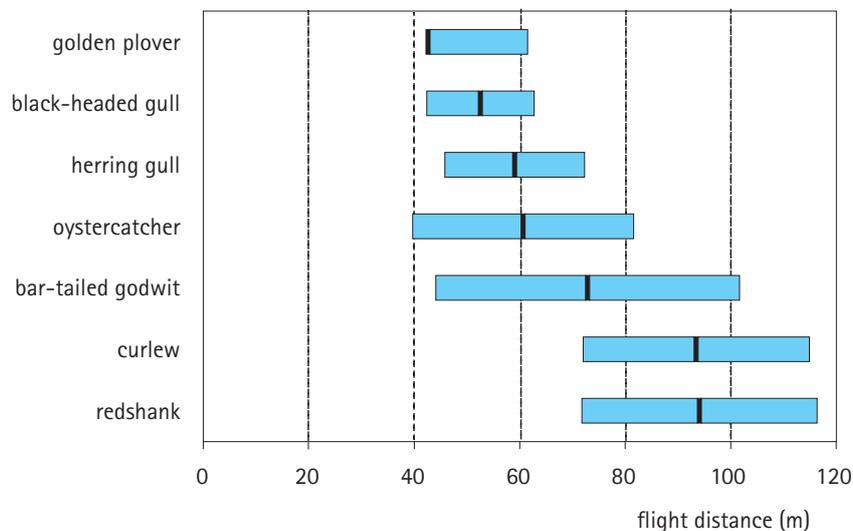


Figure 3.4: Phenology of human outdoor activities observed during monthly aerial surveys in the Danish Wadden Sea in 1980-1995, separated after North Sea beaches (upper panel) and the rest of the Danish Wadden Sea (lower panel), (after Laursen et al. 1997).

selves afterwards without the disturbance being noticed by the observer (Blew & Südbeck 1996). Surveys by Laursen et al. (1997) and Laursen & Rasmussen (2002) showed a clear relationship between the number of birds observed and the intensity of outdoor recreation, especially at the smaller salt marshes and at well accessible roosts, where birds are more easily disturbed and which were avoided when many people were around. Furthermore, e.g., Curlew are known to avoid the much visited Wadden Sea islands for roosting during the summer holidays as has been demonstrated for Ameland and Wangerooge (Kersten et al. 1997, Südbeck 1999). At Ameland, the birds returned to roost at the island during nocturnal high tides, when disturbance was absent. Curlew is generally regarded as one of the most susceptible species regarding disturbance, followed by Cormorant, Shelduck, Wigeon, Whimbrel, Redshank and Bar-tailed Godwit, i.e. in general the larger species (Smit & Visser 1993, Spaans *et al.* 1996; see also Fig. 3.5). When such species take flight, they often also cause an immediate response in other species. Besides, larger flocks (which occur at all high tide roosts) get more easily disturbed than concentrations of birds with small numbers. On the other hand, roosting flocks at inland grassland sites generally allow more human activities before taking flight as compared to birds roosting at salt marshes (Tensen & van Soest in Smit & Visser 1983), and birds respond to predictable sources of disturbance less than to unpredictable ones (Smit & Visser 1993). Walkers generally cause flight distances of up to about 200 m, with the larger species (Bar-tailed Godwit, Curlew, Redshank)

Figure 3.5:
Examples of distances at which flocks of roosting waders and gulls were recorded to take flight when approached by walking people (after Tensen & van Zoest in Smit & Visser 1993). Shown are mean values and 95% confidence limits.



being most susceptible (Fig. 3.5). Often walkers cause a relatively short period of disturbance (Smit & Visser 1993, Stock et al. 1998). Among other outdoor activities, small boats like kayaks, wind surfers, and recently also kite wind surfers seem to have the strongest impact and cause behavioural changes in roosting birds already at distances of 250-500 m (Koepff & Dietrich 1986, K. Günther, own observations).

Impact of aircraft and helicopters

Whilst outdoor activities probably represent the most frequently observed source of disturbance, aircraft and particularly helicopters are recorded to have the strongest impact. A distance where a response was triggered varies from 200 m up to 1000 m for Oystercatcher, Curlew and Bar-tailed Godwit (Visser 1986, Blankestijn et al. in Smit & Visser 1993). Visser (1986) showed that 50% of the birds responded to an approaching helicopter at distances of 600 m, whereas military jets caused only 30% response when passing even at distances < 300 m. The strong reaction to helicopters was also shown by Stock et al. (1998) in Schleswig-Holstein. Among all other sources of disturbance, helicopters by far had the strongest response when regarding the time birds were flying around after a helicopter had passed. Small civil aeroplanes seem to take an intermediate position, but cause considerable disturbance when flying at altitudes <300 m (de Vlas 1986, Heinen in Smit & Visser 1993). Only in areas with frequent and regular movements of aircraft and helicopters (i.e. flying a regular route at high altitudes, proceeding fast through an area) birds have been observed to show habituation for a certain level of disturbance (Holm 1997, Smit & Visser 1993, Smit 2000).

Impact of hunting

Flight distances are known to increase considerably when hunting occurs. Such behavioural changes have been reported for several goose and wader species (e.g. Gerdes & Reepmeyer 1983, Meltofte 1986, Wille 2000). When occurring, hunting is one of the most disturbing human activities to birds, apart from its direct negative impact on the survival and population development of birds (e.g. Ebbing 1991). Several studies have shown that waterbirds respond quickly to changes in hunting pressure, and often completely abandon areas with high hunting pressure very soon after hunting has started; or increase when hunting has ceased (see review by Madsen 1995 and Madsen & Fox 1995). A study by Frikke & Laursen (1994) showed for the Danish Wadden Sea that salt marshes with hunting were significantly less visited by dabbling ducks during the hunting season than salt marshes where hunting was prohibited. Apart from mortality, hunting causes a direct disturbance as well as an indirect disturbance, through birds (both game-species and species which are not hunted) becoming increasingly wary and more susceptible to other sources of disturbance (Madsen 1995). A strong impact from hunting has been reported for the Danish Wadden Sea, where until 1984 most wader species were game birds (Laursen 1985, Meltofte 1986).

Impact of wind turbines

Recently, several studies have been carried out to assess the impact of wind turbines on feeding and roosting birds. Especially geese seem to be highly susceptible to wind turbines, and generally tend to avoid areas within about 600 m of wind turbines, as shown by studies on White-fronted- and

Table 3.1. Summary of various sources of human disturbance and their occurrence at high tide roosts in the Wadden Sea. Disturbance has been classified as: outdoor recreation, farmers (various agricultural activities) and aircraft/helicopters. Ranking after their share in the observed number of disturbance stimuli: +++++ 1st rank; ++++ 2nd; ++ 3rd and + 4th rank.

Site/species	Recreation	Farmers	Aircraft	Source
Dutch Wadden Sea				
all species	++++	++	+++	Spaans et al. 1996
Groningen coast				
all species	++++	++	+++	Schothorst & Veenendaal 1999
Terschelling				Tensen & van Zoest in Smit & Visser 1993
Curlew	+++	++	++++	
Bar-tailed Godwit	++++	++	+++	
Oystercatcher	++++	++	+++	
gulls	+++	++	++++	
Schleswig-Holstein				
Brent Goose	++++ ¹	- ¹	+++	Stock 1993, Stock et al. 1998
Barnacle Goose	+++	-	++++	Mock & Rösner 1998

¹ includes all human activities, also hunters and agricultural activities

Barnacle Geese in Lower Saxony (Kruckenberg & Borbach-Jaene 1999, Kowallik & Borbach-Jaene 2001). Studies on roosting waders show variable results, probably depending on the local situation and the size of the wind turbines and windparks. Largest avoidance distances were found around a single large (2 MW) wind turbine at the Danish Wadden Sea coast (800 m for Lapwing and Golden Plover; Pedersen & Poulsen 1991). In Lower Saxony, several studies have revealed avoidance distances of 100 m to 500 m for most wader species (Clemens & Lammen 1995, Schreiber 2000), with largest distances found in Curlew, Golden Plover and Lapwing. At an inland site along the Friesian mainland coast in the Netherlands, more or less similar results were found (Winkelman 1992). Also here, Curlew showed the most pronounced impact and was not observed within 500 m of the outer range of the windpark. Wind turbines are also reported to have an impact on birds, which roost inland during high tide. Clemens & Lammen (1995) observed commuting birds between the intertidal areas and inland high tide roosts, which changed their flight routes after a line of wind turbines had been erected close behind the dike.

4. Habitats, Protection Regime, Disturbance

4. Review of Habitat, Protection Regimes and Potential Sources of Anthropogenic Disturbance

4.1 Introduction

This chapter aims to provide an inventory of all site data of high tide roosts in the Wadden Sea. For this purpose, the national co-ordinators of the waterbird counts collected information concerning habitat, protection regimes and anthropogenic activities at or around the roosts, according to the counting units in Figure 2.1 (i.e. including some sites outside the Wadden Sea Cooperation Area). Some of these data were assessed by using existing trilateral data from the last Quality Status Report (de Jong et al. 1999). Especially sources of potential anthropogenic disturbance were entirely based on information of the national co-ordinators and other national experts. Since we do not have direct and systematic observations of anthropogenic disturbances in the entire area, we have assumed that presenting *potential* sources of anthropogenic disturbances provide accurate information on possible interactions between roosting birds and the level of anthropogenic activities. Thus, a site with a high level of recreational activities will have a higher chance of a disturbing response to roosting birds, than a site without any recreation at all. A general review of anthropogenic activities and the known impact of these have been reviewed in chapter 3. The data presented here, is summarised in bar graphs, showing the number of areas (in %) assigned to, e.g., a certain habitat type or classified according to a certain level of anthropogenic activities (see chapter 2.4.2. for methods). For the presentation of protection regimes, these data are probably somewhat biased by the small differences in size of the counting units between the countries (which tend to be smaller in Schleswig-Holstein, see chapter 2.3.1), since we have not taken into account the actual *size* of the area (and the protected share) but the *number of sites* with a certain protection regime. For some protection regimes, inland areas and coastal sites have been treated separately.

4.2 Habitat

The habitats in which the roosts were situated differ somewhat between the countries. Obviously, all countries but the Netherlands have most high tide roosts situated at salt marshes (Netherlands 25%, others 41-52%), which generally host the highest numbers of roosting birds in all countries (see Fig. 4.1). In the Netherlands and Denmark, many roosts are situated at artificial structures (the Netherlands, mainly dikes) and at beaches and dune areas as well. However, note that these areas hold only specific species and relatively small numbers of birds (see Fig. 4.1). Besides, the Netherlands and Lower Saxony have more inland sites (36%) compared to Schleswig-Holstein and Denmark (24%), whereas sand flats are more common in Schleswig-Holstein and Denmark (on average 14%, compared to 6% in the Netherlands and Lower Saxony). In the Netherlands, Lower Saxony and Denmark, the inland sites mainly represent agricultural areas (73-81%) whereas in Schleswig-Holstein, inland roosting sites mainly comprise wetland areas. This, however, does not entirely reflect a true difference but also points at a different situation of the counting units. In Schleswig-Holstein, only very few agricultural ar-

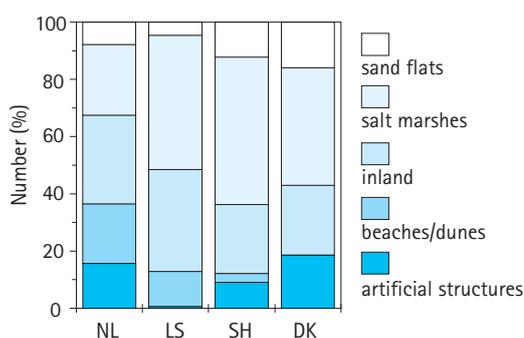


Figure 4.1: High tide roosts in the Wadden Sea in relation to habitat. Habitats have been distinguished after artificial structures (dikes, breakwaters in harbours, platforms), beaches and dunes (mainly North Sea coast), inland areas (agricultural areas as well as semi-natural wetlands), salt marshes and sand flats. Countries are DK Denmark, SH Schleswig-Holstein, LS Lower Saxony and NL the Netherlands.

eas are covered during the waterbird counts, since most inland high tide roosts are situated in inland wetland areas, which are lacking in e.g. the Netherlands and Lower Saxony.

4.3 Protection regimes

International protection regimes

The outstanding importance of the Wadden Sea for migratory and breeding birds is recognised in many conventions and regulations (see also re-

view in de Jong et al. 1999). Major parts of the Wadden Sea have been designated as Ramsar sites (Fig. 4.2). These include also most of the high tide roosts (Fig. 4.3). Coverage is higher in Schleswig-Holstein and Denmark (85% and 86% of all sites respectively), although this includes sites which are only partly situated within the boundaries of the Ramsar area. In Denmark, numerous inland sites (marshes and wetlands like Margrethe Kog and Tøndermarsken) are included as well.

In the Netherlands and Lower Saxony, 30% of

Figure 4.2: Ramsar sites in the Wadden Sea (source: CWSS 2003).

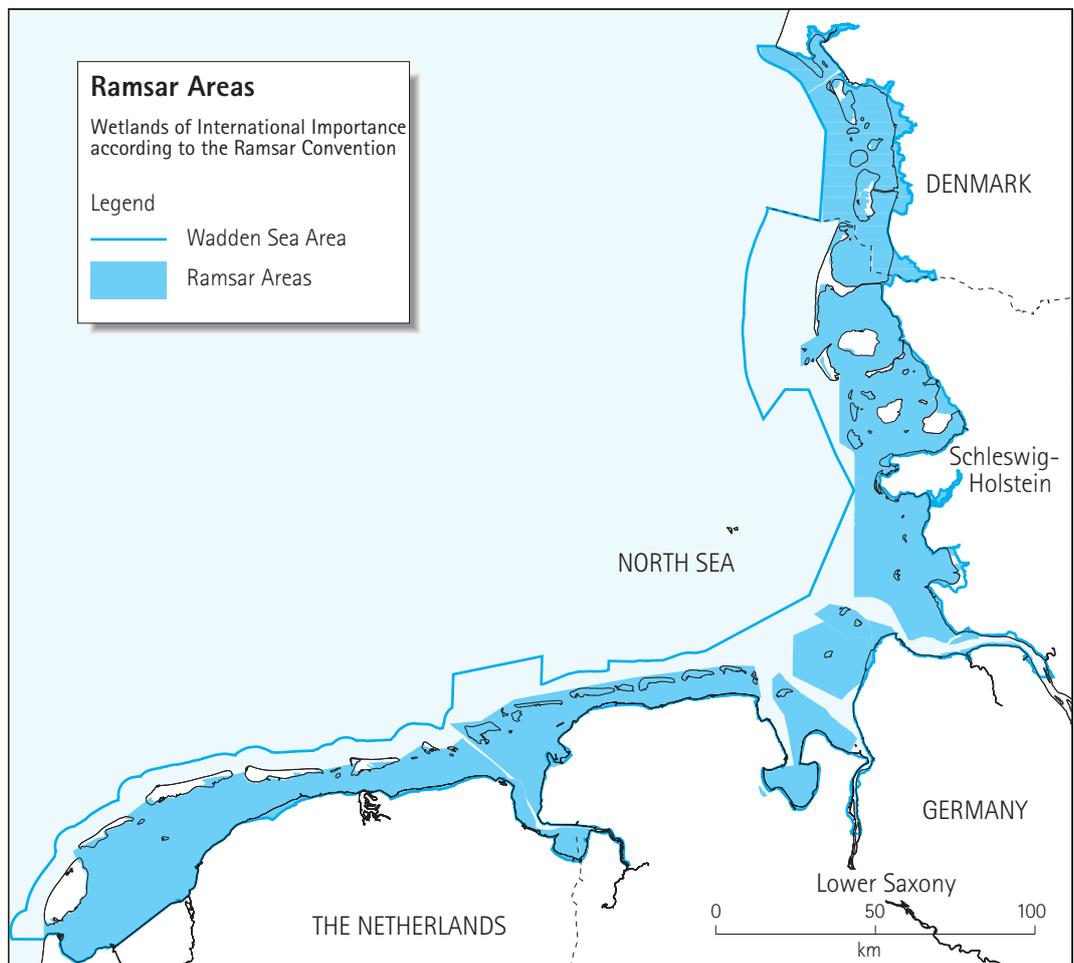
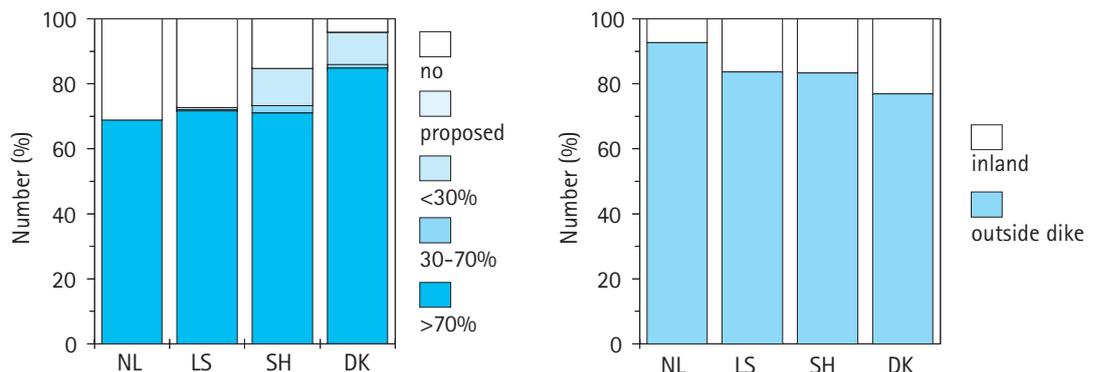


Figure 4.3: Proportion of high tide roosts in the Wadden Sea which are designated as Ramsar sites. The division of Ramsar sites is also shown separately for inland areas and coastal areas (outside the dikes), in the right panel. Colors indicate partial coverage (>70%, 30-70% or <30% of the roosting site within Ramsar boundaries). Countries are DK Denmark, SH Schleswig-Holstein, LS Lower Saxony and NL the Netherlands.



the roosts are not part of the Ramsar area, which is mainly explained by the high proportion of inland roosts on agricultural fields in these parts of the Wadden Sea (see chapter 4.2). Especially in the Netherlands, only a minor part of these kind of inland roosts have been designated as Ramsar site (Fig. 4.3, right panel).

The designation of SPAs (EC-Bird Directive) is highly comparable to Ramsar sites. Basically, the entire Wadden Sea (except main shipping lanes) has been designated as SPA, including a three-

sea-mile offshore (de Jong et al. 1999, Fig. 4.4). Again, Denmark and Schleswig-Holstein have a higher coverage when considering the situation of high tide roosts (98% and 92% respectively; Fig. 4.5). The lower proportion of roosts covered by SPAs in the Netherlands also expresses here the large share of inland roosts in agricultural areas, which have been excluded in the SPA boundaries. Compared to the Netherlands, Lower Saxony has taken into account several important inland roosting sites within the SPA designation.

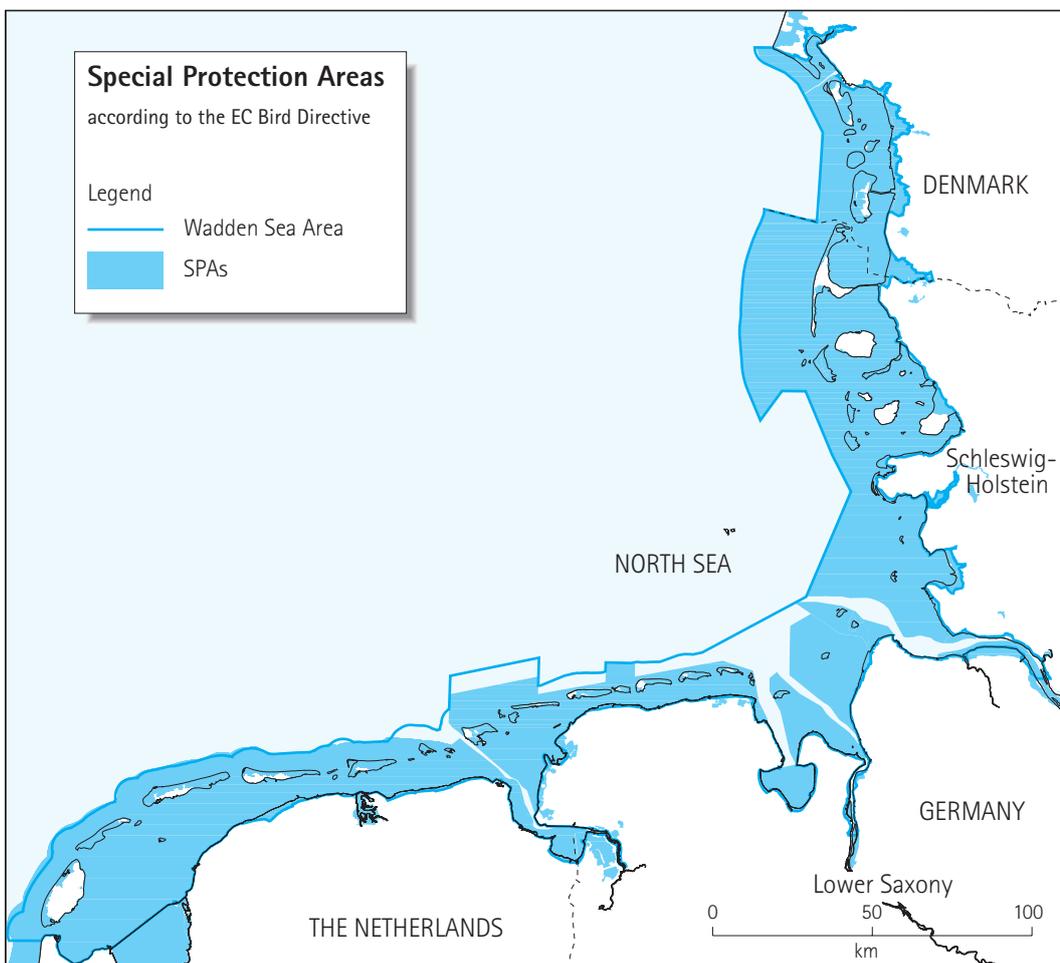


Figure 4.4: Special Protection Areas (SPAs) in the Wadden Sea (source: CWSS 2003).

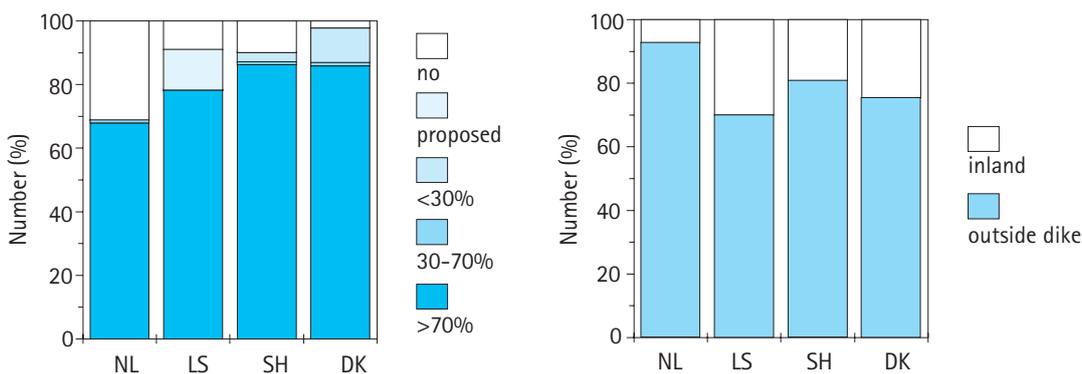


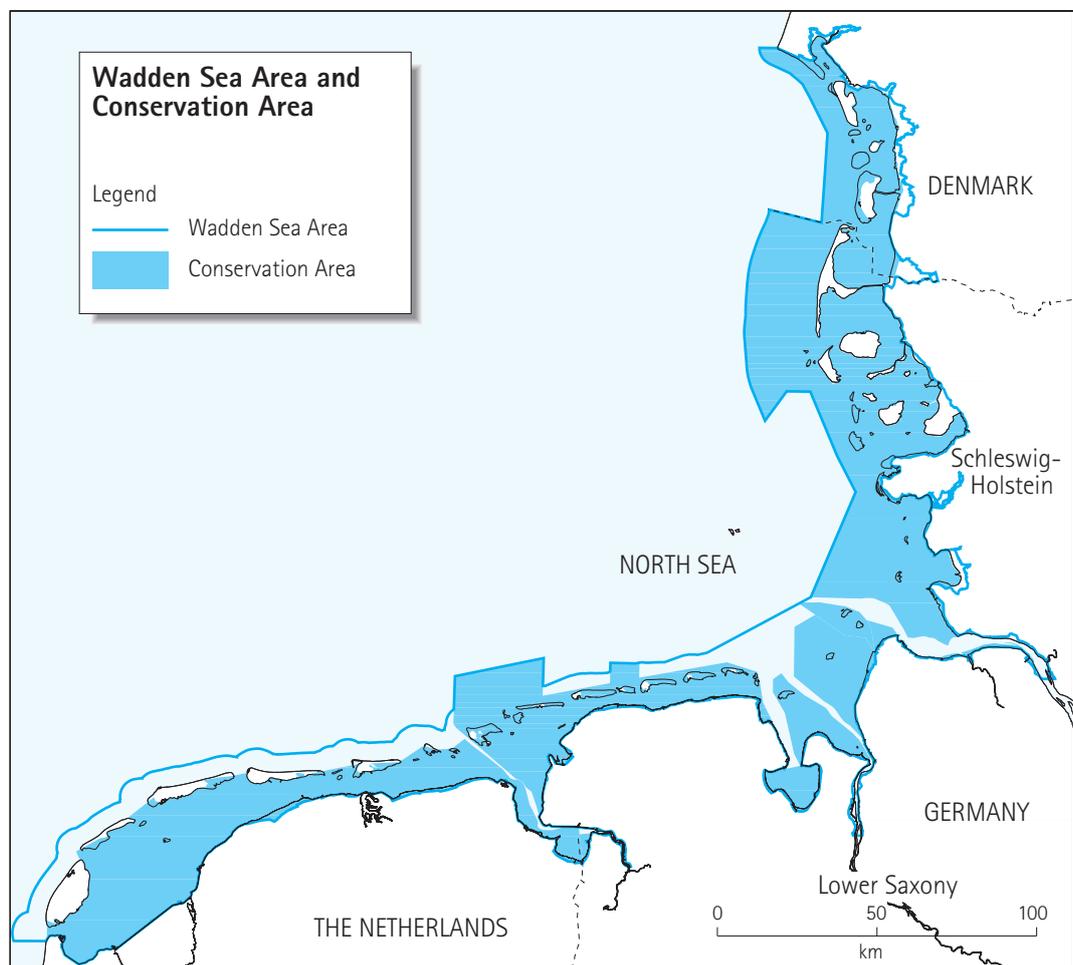
Figure 4.5: Proportion of high tide roosts in the Wadden Sea which are designated as Special Protection Areas (SPAs). The division of SPAs is also shown separately for inland areas and coastal areas (outside the dikes), in the right panel. Colors indicate partial coverage (>70%, 30-70% or <30% of the roosting site within SPA boundaries). Countries are DK Denmark, SH Schleswig-Holstein, LS Lower Saxony and NL the Netherlands.

Trilateral Wadden Sea Cooperation

In the framework of the Trilateral Wadden Sea Cooperation the Wadden Sea Conservation Area is the heart of the regime consisting of the Wadden Sea national parks and nature reserves. These national protection and management regimes are the total legal and administrative instruments that have been enacted and implemented to protect, conserve and manage the Wadden Sea in a sustainable way corresponding with the trilateral objectives, principles and agreements. The Wadden Sea Plan respectively the WSP project 34 is

(2001) the national park area in Lower Saxony has expanded (which was not taken into account since bird numbers were collected before 2001, see chapter 2.4.1 and 2.4.2). The national park area covers salt marshes, the intertidal area, the islands, some inland areas and parts of the open water (main shipping lanes and villages at the islands are excluded). The national park is divided into three zones with different regulations. The core zone, the so-called zone 1 or 'Ruhezone' covers 54% of the entire national park and prohibits public access outside assigned tracks and routes.

Figure 4.6: National protection regimes in the Wadden Sea (source: CWSS). The area shown is also known as the Trilateral Conservation Area. For Lower Saxony, also the recent extension of the National Park in the Dollart area is shown (which was not taken into account during data analysis because all data originate from before the extension).



valid for the broader Wadden Sea Area, for which other national instruments are also being applied.

National protection regimes

In Lower Saxony, the 'Nationalpark Niedersächsisches Wattenmeer' covers about 2,400 km², the smaller Hamburg National Park around Scharhörn and Neuwerk about 100 km². Both national parks are being jointly taken into consideration as "National Park Lower Saxony" in this report. Recently

A minor part of these sites (<50% of the salt marsh and polder areas) are in agricultural use, with various restrictions concerning farming-intensity, especially in state-owned areas. Hunting is strongly regulated and allowed only within existing contracts and special permits. Most high tide roosts are situated in this core zone of the national park (Fig. 4.7). The rest of the national park area is assigned as intermediate zone (zone 2 'Zwischenzone', 45%) or recreational zone (zone 3 'Erhol-

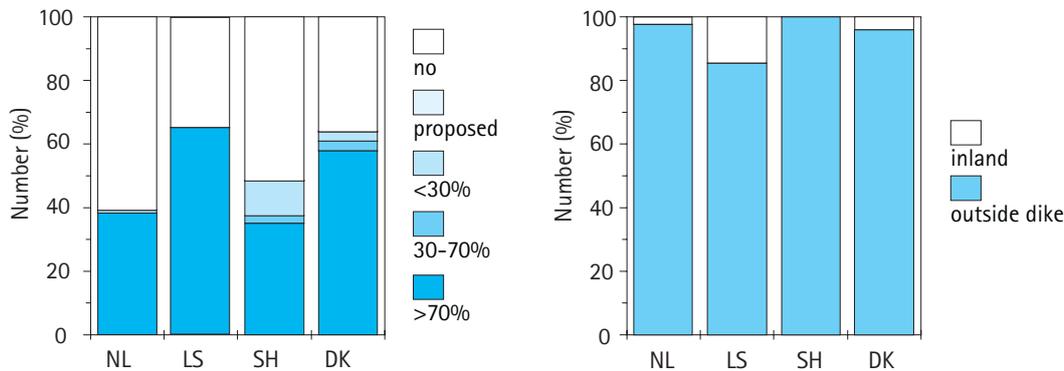


Figure 4.7: Proportion of high tide roosting sites in the Wadden Sea which are subject to national protection regimes (designated as National Parks in Germany or as Nature and Wildlife Reserve and 'Key Planning Decision Wadden Sea' in Denmark and the Netherlands respectively). The division of roosting sites is also shown separately for inland areas and coastal areas (outside the dikes), in the panel below. Colors indicate partial coverage (>70%, 30-70% or <30% of the roosting site within boundaries of national protection regime). Countries are DK Denmark, SH Schleswig-Holstein, LS Lower Saxony and NL the Netherlands.

ungszone', 1%). Here, public access is allowed, except for salt marshes in zone 2, within the breeding season from 1 April - 31 July. Besides the roosting sites in the national park, 16 sites (9%) are protected as nature reserve.

The 'Nationalpark Schleswig-Holsteinisches Wattenmeer' was extended from 2,720 km² to 4,410 km² in 1999. Moreover, the original three zones were aggregated to two, of which the core zone (zone 1) covers 36% of the entire national park. Delineation of the national park boundaries, limitations and regulations differ from Lower Saxony. Firstly, the national park in Schleswig-Holstein does not cover the main islands and the larger populated Halligen (only the smallest Halligen are included; Fig. 4.6) and it excludes an area within 150 m seaward from the dike as well. Many of these sites have been designated as nature reserves (overall, 35% of the roosting sites in Schleswig-Holstein which are not included in the national park, have been designated as nature reserve). In the core zone, limited public access is allowed within 1,000 m of the dike seaward, at assigned tracks and routes or at other specially assigned sites. High tide roosts are both situated in zones 1 and 2. Of the high tide roosts in Schleswig-Holstein, 48% is situated within the national park area (Fig. 4.7).

The Danish part of the Conservation area is the Nature and Wildlife Reserve Wadden Sea (Fig. 4.7). This area of about 1,000 km² covers salt marshes, the intertidal area as well as a few inland sites (e.g. Margrethe Kog) and some beaches at the islands. From the roosting sites, a majority (64%) is situated within this area (another 29% has been

designated as nature reserve). About 10% of the reserve is designated as a core zone, with limited or no public access. The other two zones, 60% and 30% of the reserve respectively, partly consist of open water or intertidal areas. These zones regulate and allow recreational activities and hunting, although the latter only in some salt marshes situated close to the seawall. High tide roosts are mainly situated in zones 1 and 2.

In the Netherlands, regulations concerning the Wadden Sea have been included in the so-called 'Key Planning Decision Wadden Sea' (Wadden Sea Memorandum). This document regulates all planning and nature conservation matters within the Dutch part of the Wadden Sea. It covers about 2,400 km² and is delineated by the seawalls (including regularly flooded areas at the islands as well). Most parts of the Wadden Sea Memorandum are also designated as nature reserve. Of all high tide roosts, 38% is situated within the area the regulations apply to (Fig. 4.7). The area constitutes of three zones, which are designated according to legal status of the areas and allow different human activities. About 7% of the area is designated as a special protection zone (with no public access), which covers mainly roosts for seals and important concentrations of breeding birds. The remaining area, where also most high tide roosts are situated, allows public access in most cases. Exception here are some nature reserves (e.g. Griend, Boschplaat/Terschelling) which have limited access year-round or during the breeding season. Overall, 25% of the roosting sites which are not subject to the 'Key Planning Decision Wadden Sea' have an additional designation as a nature reserve.

4.4 Potential anthropogenic disturbance

Farming

Together with hunting and fisheries, farming is the oldest traditional source of human exploitation in the Wadden Sea. With respect to high tide roosts, farming mainly occurs at salt marshes and at inland sites (Fig. 4.8). In most countries, the

proportion of roosts where farming occurs is about 50-60%, except for Schleswig-Holstein, where 79% of the roosting sites are subject to farming (Fig. 4.9). However, intensity differs largely between the countries. Whilst Denmark, Lower Saxony and the Netherlands have quite a large proportion of heavy agriculturally used sites (i.e. mainly the inland areas), Schleswig-Holstein has only low or moderately used areas, which mainly refer to grazed sites. Since the delineation of counting

Figure 4.8: Overview of farming at high tide roosts in the Wadden Sea. Classification was carried out according to expert judgement of national specialists and does not refer to true assessments. Salt marshes have been categorized as either 'low' or 'moderate' (depending on grazing intensity), crops and improved grassland as 'heavy'. Note that in Schleswig-Holstein, agricultural areas inland are hardly covered in the counts.

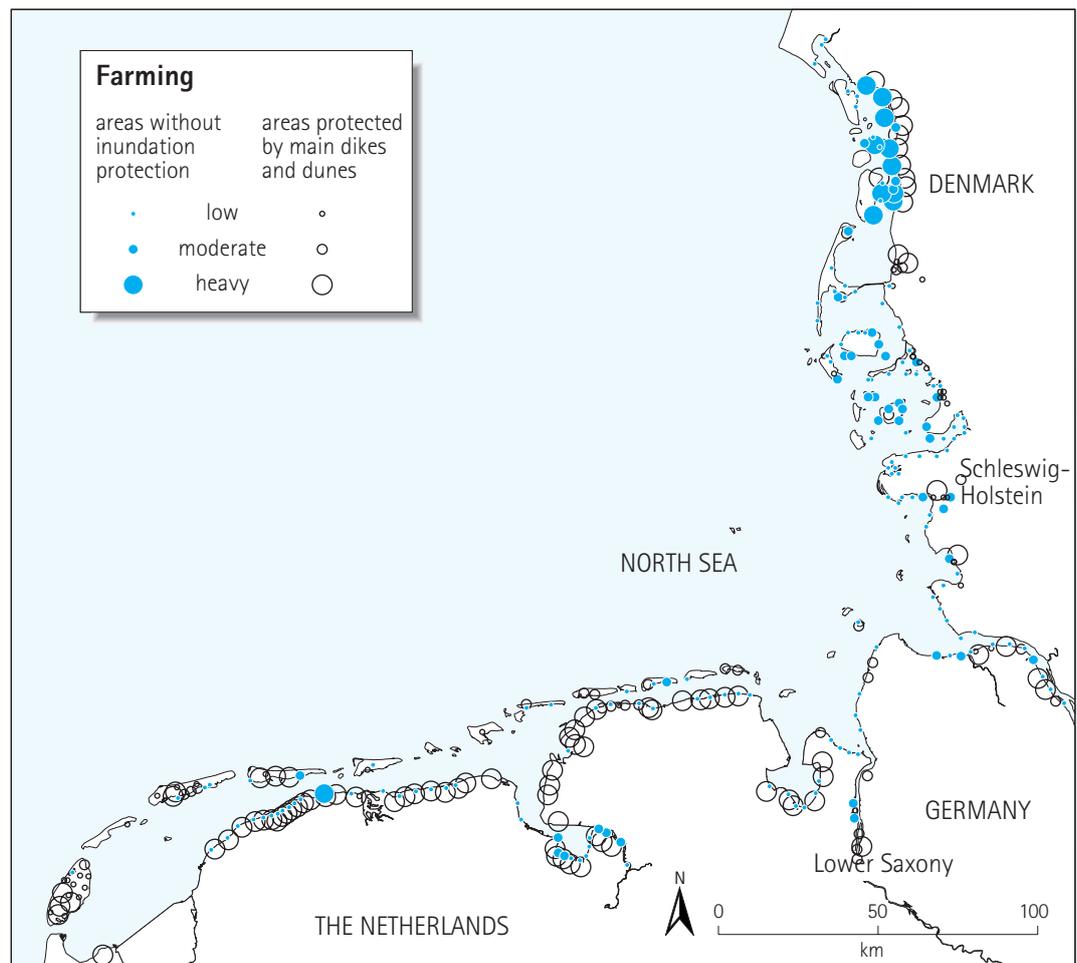
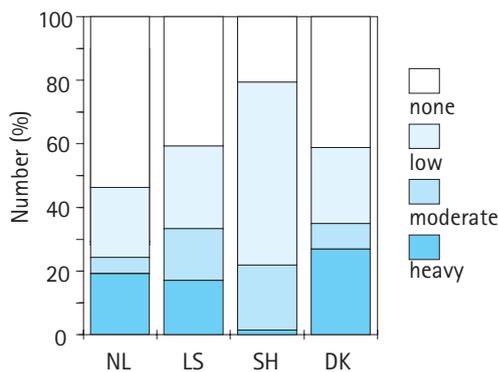


Figure 4.9: Proportion of high tide roosts in the Wadden Sea which are subject to potential disturbance from farming. Intensity of farming ranges from 0 'no' to 3 'heavy' (see Fig. 4.8 for explanation). Countries are DK Denmark, SH Schleswig-Holstein, LS Lower Saxony and NL Netherlands.



units is somewhat different here (inland sites mainly cover wetland areas and only few agricultural areas), this difference is mainly explained by the sites taken into consideration. Although farming occurs in large parts of the Wadden Sea, it is assumed that the direct impact with respect to disturbance is rather small (see chapter 3.4.2).

Hunting

Hunting is common practice in the Wadden Sea, although widely regulated in time and space (see also de Jong et al. 1999). We have only considered hunting in areas where also roosts are situated, i.e. hunting on open water, common practice in Denmark, has not been taken into consideration here. Furthermore hunting on waterbirds as well as hunting on Hare *Lepus europaeus* or Rabbit *Oryctolagus cuniculus* have been consid-

ing pressure has decreased here after new legislation in 1992, hunting in a narrow strip along the mainland coast (as well as hunting from anchored vessels and by wading at sites west of a line between the islands) is allowed between 1st October and 31st January. In Lower Saxony, there is an open season for waterbirds at the inhabited islands during 10 days of the year. Moreover, hunting on Hare and Rabbit is carried out in some parts of the national park and (more frequently) in in-

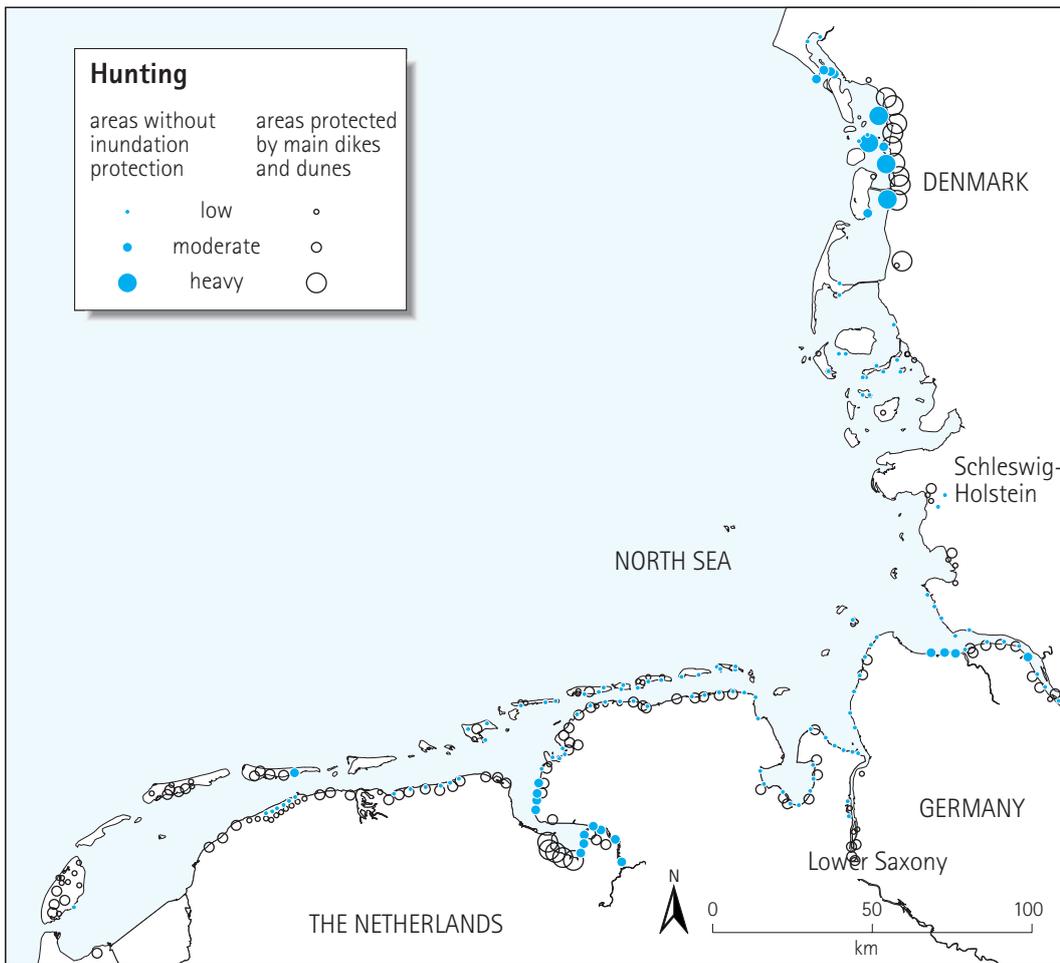


Figure 4.10: Overview of hunting at high tide roosts in the Wadden Sea. Classification was carried out according to expert judgement of national specialists and does not refer to true assessments. Classification runs from 0 'no hunting' to 3 'heavy hunting'. The latter is mainly concentrated at the open season for waterbirds and rabbits and hare, from October - January. Note that in Schleswig-Holstein, agricultural areas inland were hardly covered during the counts and therefore information on hunting in those areas has not been included.

ered, since both affect the attendance of waterbirds at high tide roosts when occurring nearby (e.g. Schothorst & Veenendaal 1999). When taking into account heavy and moderate hunting pressure, Denmark and Lower Saxony have the highest amount of hunting activities in the Wadden Sea (16% and 33% of the sites respectively; Fig. 4.11). However, heavy hunting pressure only occurs in Denmark, whereas in Lower Saxony a moderate hunting pressure is mainly reported from inland sites along the mainland coast. In Denmark, hunters' activities are concentrated along the mainland coast as well (Fig. 4.10). Although hunt-

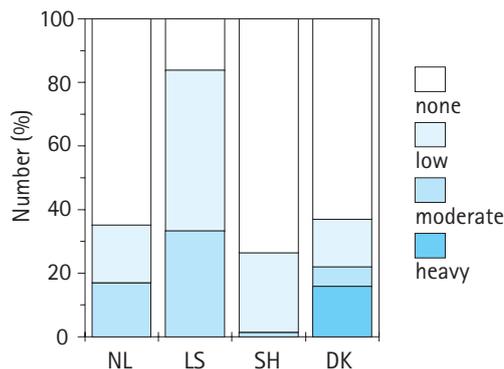


Figure 4.11: Proportion of high tide roosts in the Wadden Sea which are subject to potential disturbance from hunting. Intensity of hunting ranges from 0 'no' to 3 'heavy', according to expert judgement (see Fig. 4.10 for explanation). Countries are DK Denmark, SH Schleswig-Holstein, LS Lower Saxony and NL the Netherlands. Note that in Schleswig-Holstein, agricultural areas inland were hardly covered during the counts and therefore information on hunting in those areas has not been included.

land agricultural areas. In the Netherlands, hunting is concentrated in inland areas (altogether, 17% of the roosting sites is subject to moderate hunting pressure). Hunting on migratory waterbirds has been forbidden here since 2001 (with major restrictions already in 1999). During the period which is covered by this report, there was an open season for Wigeon and other waterbirds, between 1 October - 31 January.

In Schleswig-Holstein, hunting in the national

park has been forbidden by law since 1999. Before, regulations at different roosting sites were variable (see de Jong *et al.* 1999 for details). Outside the national park only few sites (2%) are expected to have an impact from moderate hunting. Since agricultural areas have hardly been taken into account here, hunting pressure is probably slightly underestimated. Hunting on some waterbirds is allowed at the islands and in agricultural areas behind the dikes (which are not covered by

Figure 4.12: Overview of oil- and gas exploitation at high tide roosts in the Wadden Sea. Classification was carried out according to expert judgement of national specialists and is partly based on trilateral data (de Jong *et al.* 1999). Classification runs from 0 'no activities' to 2 'moderate activities'.

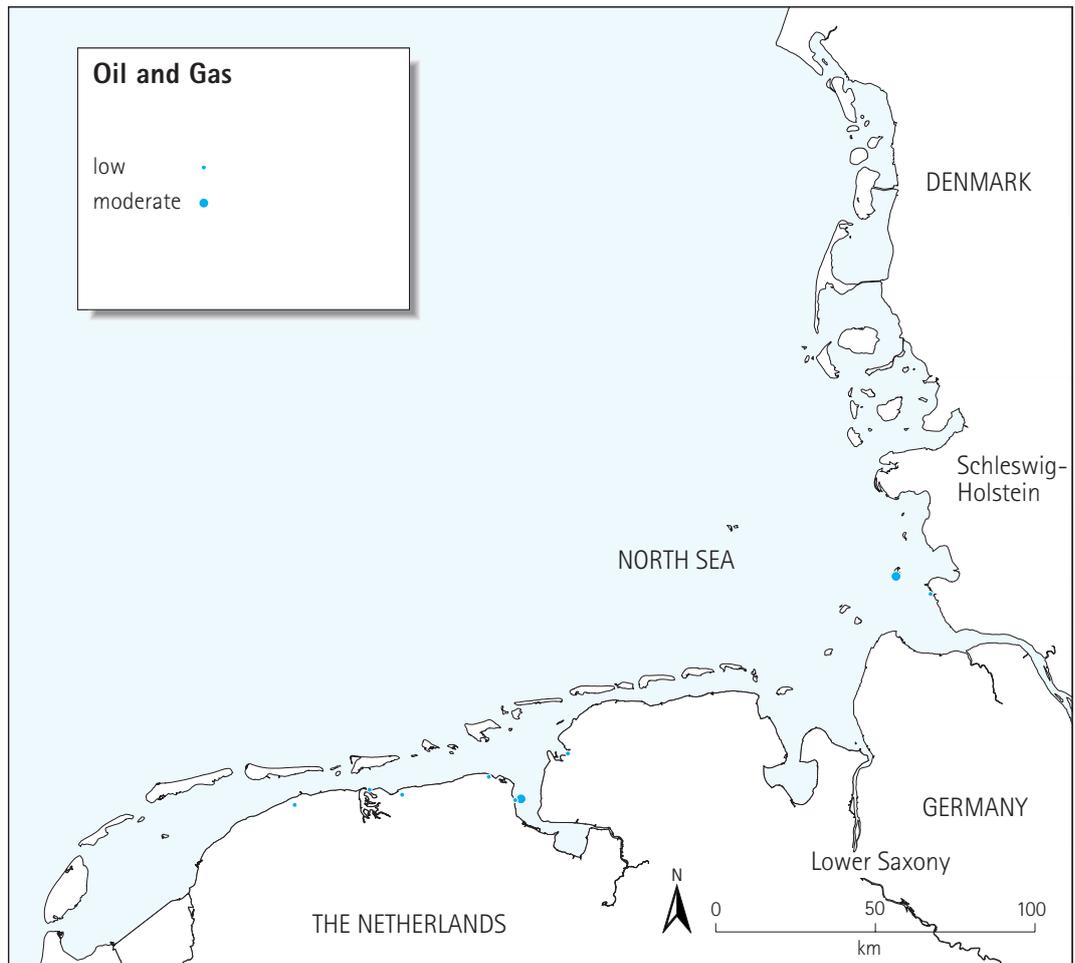
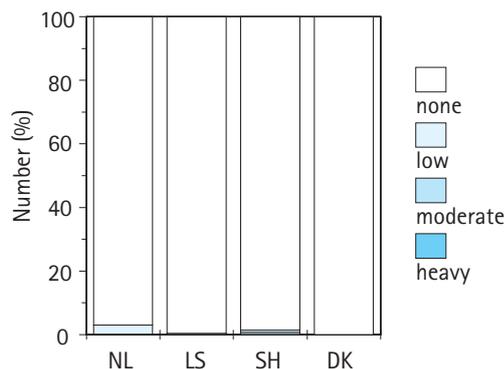


Figure 4.13: Proportion of high tide roosts in the Wadden Sea which are subject to potential disturbance from oil- and gas exploitation. Intensity of activities ranges from 0 'no' to 2 'moderate', according to expert judgement and trilateral data (de Jong *et al.* 1999). Countries are DK Denmark, SH Schleswig-Holstein, LS Lower Saxony and NL the Netherlands.



waterbird counts and therefore not included in this report!). New regulations came into force in 2002 (MUNF 2002), with no further regular hunting on gulls, Bean- and Brent Goose. Hunting on Barnacle Goose and Wigeon is allowed in case crop damage occurs.

Oil and gas exploitation

There is only a limited number of sites in the Wadden Sea where potential disturbance of oil- and gas platforms occurs close to high tide roosts. These include a number of inland exploitation sites in the Netherlands (Groningen/Friesland), the 'Hond' island at the Ems Estuary at the border of

the Netherlands and Lower Saxony, and the "Mitteplate", a platform near Trischen in Schleswig-Holstein (Fig. 4.12, 4.13; cf. de Jong *et al.* 1999).

Military training

Military training areas are located at or around a few high tide roosts in the Wadden Sea (cf. de Jong *et al.* 1999). Main activities are situated in the Netherlands (11% of the high tide roosts; Fig. 4.14, 4.15). These include intense traffic of mili-

ters. This site is currently used about 10-20 days/year (de Jong *et al.* 1999). A second exercise area at Königshafen, Sylt, was abandoned in 1992. In Denmark, a similar shooting range like Vlieland is situated at Rømø (although involves shooting from military jets only). Furthermore, an amphibian exercise area is used at Ho Bugt and Skallingen a few days a year, but this site is not covered by waterbird counts and therefore has not been included in this report.



Figure 4.14: Overview of military training areas at high tide roosts in the Wadden Sea. Classification was carried out according to expert judgement of national specialists and is partly based on trilateral data (de Jong *et al.* 1999). Classification runs from 0 'no activities' to 3 'heavy activities'.

tary aircraft/helicopters (around Den Helder/Texel), a military training area (Texel) and shooting ranges at Texel, Breezanddijk (Afsluitdijk), Vlieland and Lauwersmeer. The shooting range 'Noordsvaarder' at Terschelling was closed in 1995 and is therefore not included here (although it was used during part of the period covered by this report). The site Vliehors at Vlieland involves ground-based shooting as well as shooting from military jets (with lowest intensity between 1 March - 15 September). In Schleswig-Holstein, a test site for new weapons is situated in the Meldorfer Bucht, which involves shooting and intense traffic of helicop-

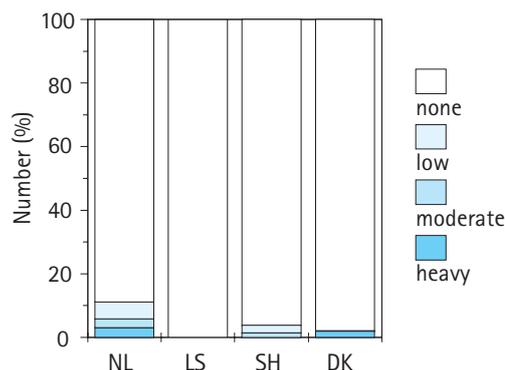


Figure 4.15: Proportion of high tide roosts in the Wadden Sea which are subject to potential disturbance from military training. Intensity of activities ranges from 0 'no' to 3 'heavy', according to expert judgement and trilateral data (de Jong *et al.* 1999). Countries are DK Denmark, SH Schleswig-Holstein, LS Lower Saxony and NL the Netherlands.

Civil aviation

Within the Wadden Sea, several smaller airports exist, especially in Lower Saxony, at the islands (de Jong et al. 1999). This is also expressed by the potential disturbance estimated for high tide roosts, which shows concentrations in Lower Saxony (Fig. 4.16, 4.17). However, the distribution is scattered, and only 5% of the sites has moderate to heavy air traffic in close vicinity to high tide

roosts, with concentrations at the islands. In the Netherlands, fewer airports exist (Den Helder, Texel and Ameland) and up to 4% of the roosts is estimated to have moderate to heavy air traffic around (and 16% is reported to have low-intensity traffic). Moreover, low-flying planes are reported from the Groningen coast where an exercise area for emergency landings is situated in the Noordpolder. In Schleswig-Holstein, most disturbance is to be

Figure 4.16: Overview of intensity of civil air traffic at high tide roosts in the Wadden Sea. Classification was carried out according to expert judgement of national specialists and is partly based on trilateral data (de Jong et al. 1999). Classification runs from 0 'no air traffic' to 3 'heavy air traffic'.

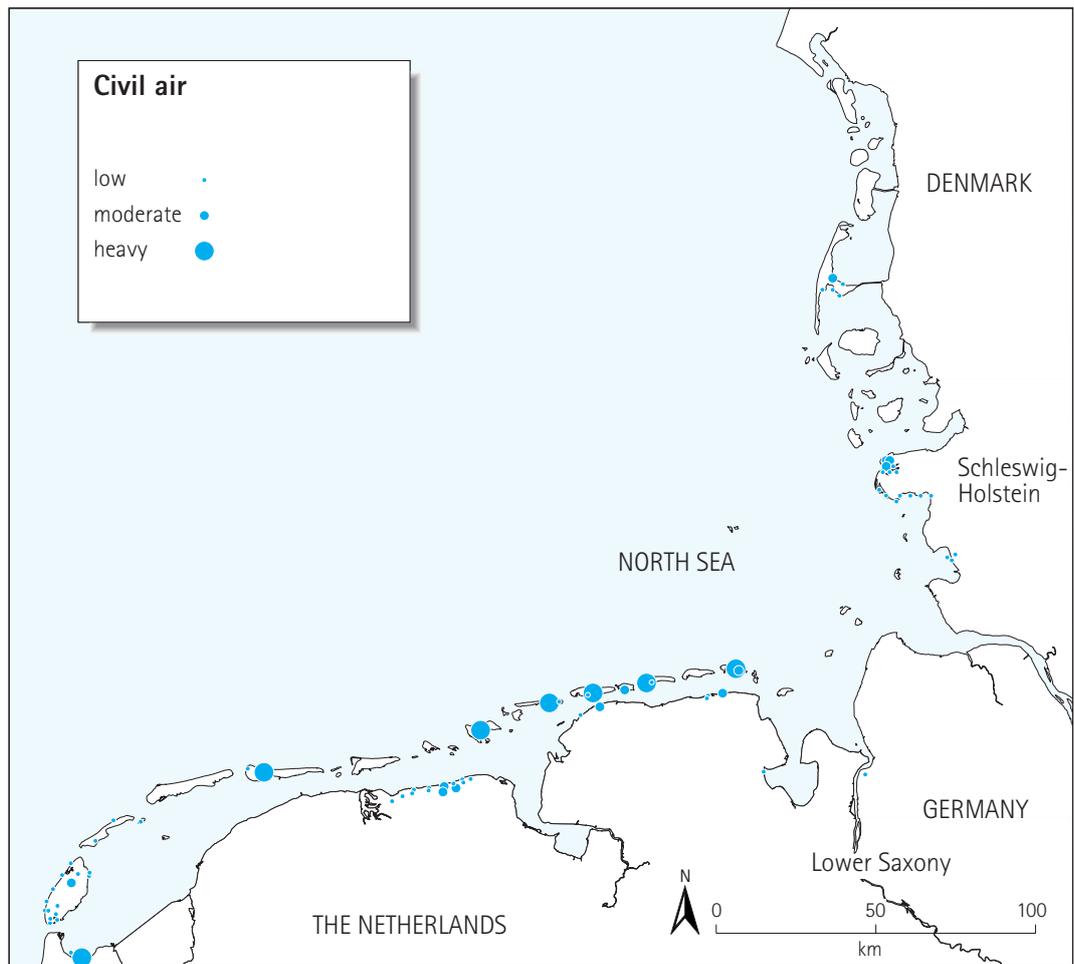
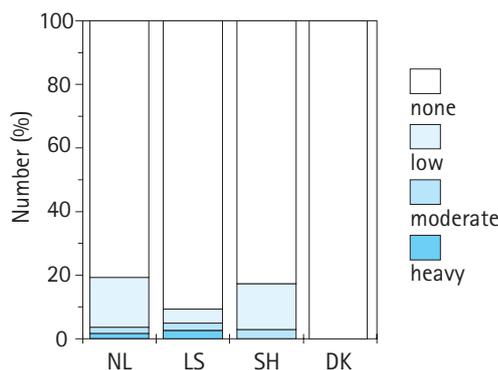


Figure 4.17: Proportion of high tide roosts in the Wadden Sea which are subject to potential disturbance from civil air traffic. Intensity of traffic ranges from 0 'no' to 3 'heavy', according to expert judgement and trilateral data (de Jong et al 1999). Countries are DK Denmark, SH Schleswig-Holstein, LS Lower Saxony and NL the Netherlands.



expected from sight-seeing flights, e.g. around the lighthouse of Westerhever (altogether, 3% of the sites is estimated to have moderate to heavy air traffic). In Denmark no potential disturbance from civil aircraft is reported.

Wind parks

More and more wind turbines were built along the Wadden Sea coasts over the past decade, especially in Germany (de Jong et al. 1999). In Lower Saxony, it involves 33% of the roosting sites (note: only sites with wind turbines within 1 km of the roost have been taken into account), of which 6% refers to wind parks (Fig. 4.19). In Schleswig-Holstein numerous wind farms exist as

well, although a much smaller proportion appears to be close to roosting sites (23%). In the Netherlands and Denmark, wind turbines appear around 12% and 7% of the sites respectively. Concentrations are in Groningen (Lauwersoog, Emmapolder) and in NW-Lower Saxony (Fig. 4.18).

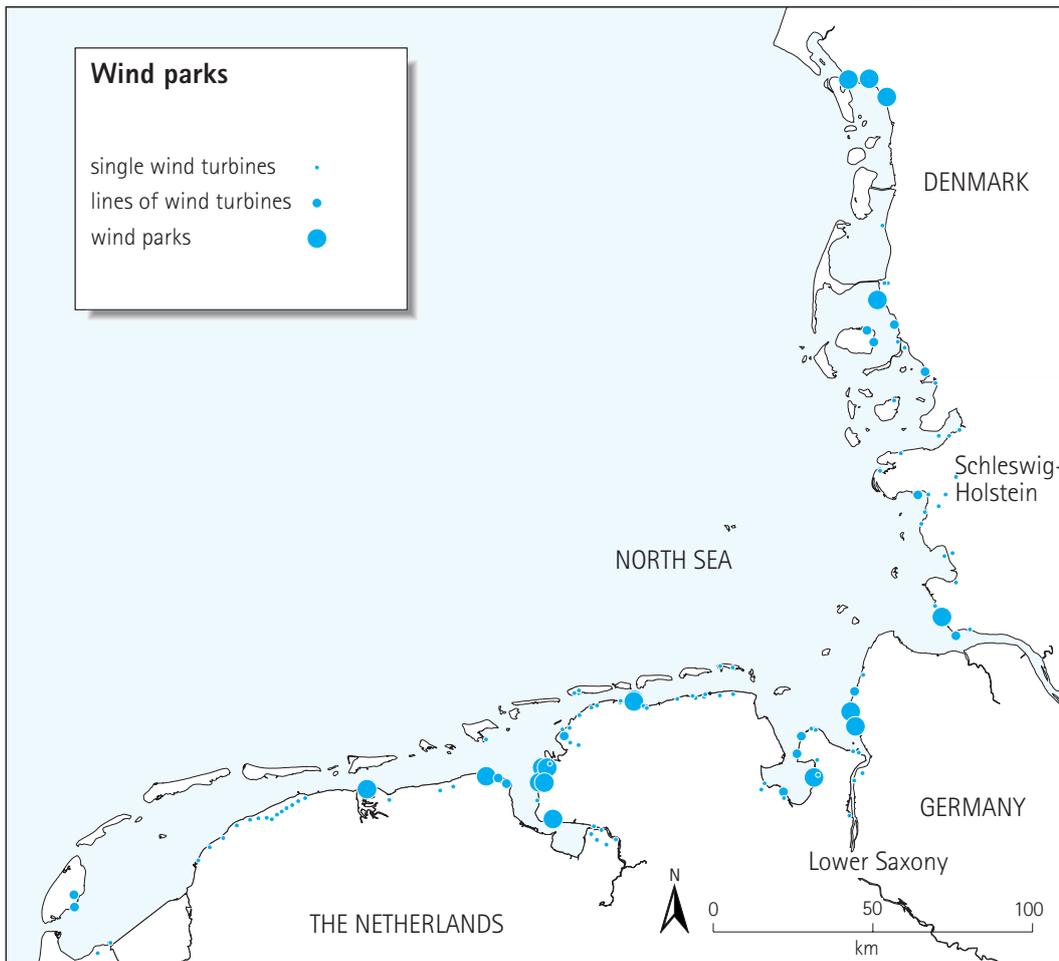


Figure 4.18: Overview of situation of wind turbines at high tide roosts in the Wadden Sea. Classification was carried out according to expert judgement of national specialists and refers only to wind turbines within 1 km of a roosting site. Classification represents different types of wind turbines, either single turbines (1), lines of turbines (2) or wind farms (3).

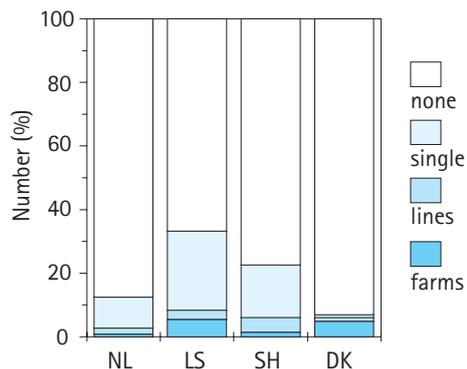


Figure 4.19: Proportion of high tide roosts in the Wadden Sea which are subject to potential disturbance from wind turbines. Assessment based on expert judgement and refers only to wind turbines within 1 km of a roosting site. Classification represents different types of wind turbines, either single turbines (1), lines of turbines (2) or wind farms (3). Countries are DK Denmark, SH Schleswig-Holstein, LS Lower Saxony and NL the Netherlands.

Recreational activities

From all anthropogenic activities considered here, recreational activities are by far the most observed potential sources of disturbance. These involve various activities like beach-visiting, day-hiking, tidal flat walking, kite-flying, recreational boating, wind and kite surfing, sea-kayaking, angling and bait-digging. Both the intensity of recreational activities as well as the occurrence throughout

the year has been reported to increase (e.g. de Jong et al. 1999). Both Lower Saxony and Schleswig-Holstein have the highest proportion of roosting sites subject to potential disturbance from recreation (90% and 91% of the sites respectively; Fig. 4.21). However, these often refer to a low intensity of activities, concentrated, e.g., on weekends and during holidays. When regarding moderate and heavy intensity of recreation, including large num-

Figure 4.20: Overview of situation of recreational activities at high tide roosts in the Wadden Sea. Classification was carried out according to expert judgement of national specialists and runs from 0 'no activities' to 3 'heavy activities'.

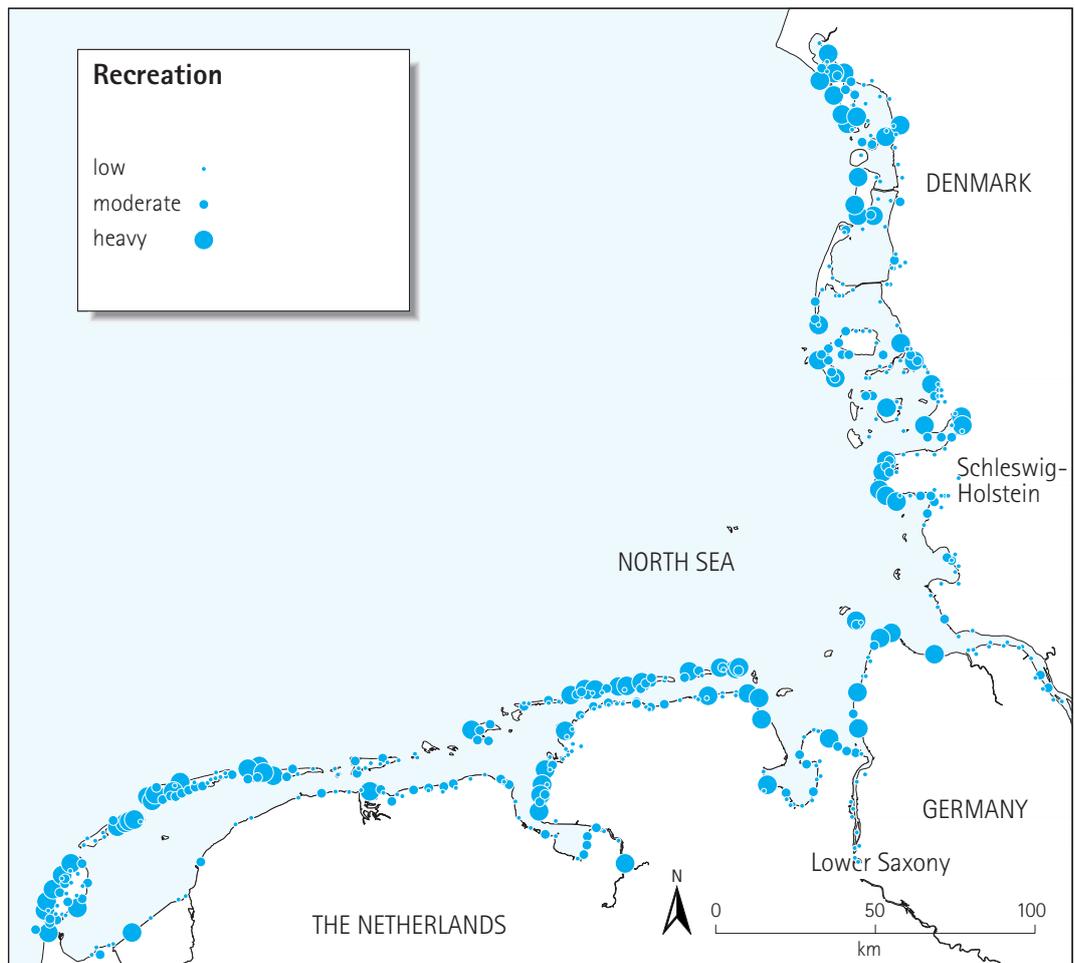
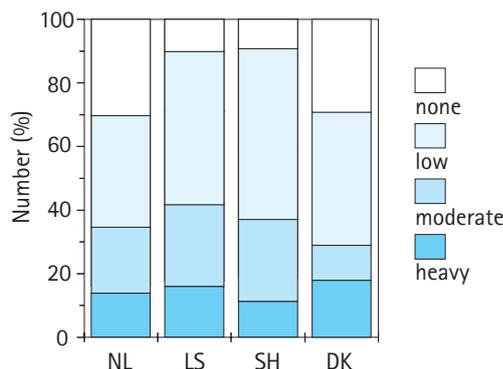


Figure 4.21: Proportion of high tide roosts in the Wadden Sea which are subject to potential disturbance from recreational activities. Intensity of recreational activities ranges from 0 'none' to 3 'heavy', according to expert judgement. Countries are DK Denmark, SH Schleswig-Holstein, LS Lower Saxony and NL the Netherlands.



bers of visitors and a widespread distribution throughout the year, 29% (Denmark) to 42% (Lower Saxony) of the roosting sites are involved. In the Netherlands and Lower Saxony, most recreational activities are concentrated at the islands (Fig. 4.20). Lower Saxony also has several strongholds at the mainland coast. In Schleswig-Holstein, recreation is concentrated at the northern part, in North-Friesland, both at islands and the mainland coast. In Denmark, recreational activities are mainly reported from the islands and the coast north of Esbjerg and the west coast of Skallingen.

Accessibility

Recreational activities are assumed to be closely related to the accessibility of roosting sites. Therefore, we have also assessed accessibility of roosting sites with respect to public access. Our data support the hypothesis that accessibility and the level of recreational activities are associated (chi-square test, chi-square = 104.5, df = 9, p < 0.001). When considering direct access to the roost, ei-

ther by foot or by motorised transport (i.e. cars), Denmark and the Netherlands have generally better access to roosts (72% and 76% of the roosting sites respectively; Fig. 4.22, 4.23) than Lower Saxony (33%), which is probably explained by the national park regulations in Lower Saxony, which prohibits human access to major parts of the roosting sites (see national protection regimes). Moreover, out of the seven inhabited islands, only two are accessible by cars. Schleswig-Holstein takes an intermediate position as quite many roosting areas (57%), also in parts of the national park, are accessible for e.g. hikers. When regarding access

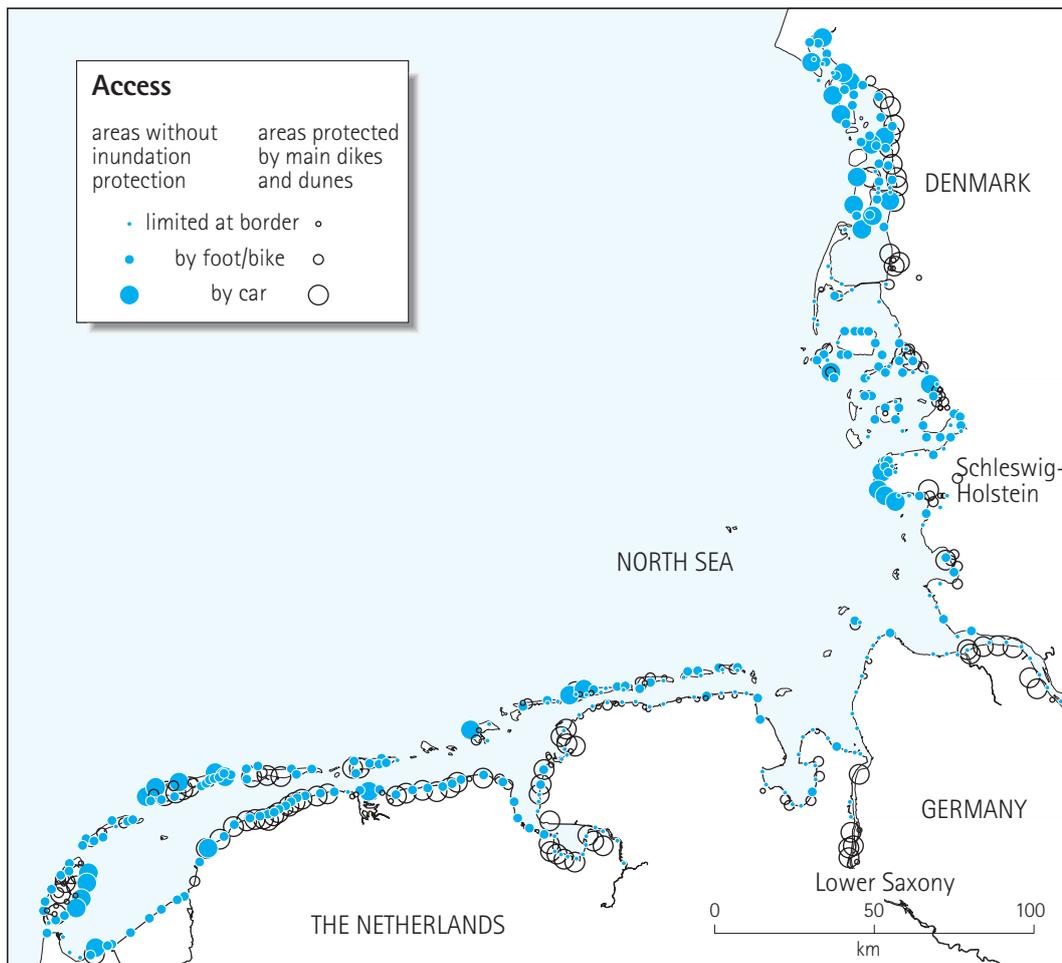


Figure 4.22: Overview of accessibility of high tide roosts in the Wadden Sea. Classification was assessed according to expert judgement of national specialists and refers to 0 'no public access'; 1 'accessible only at the borders of the roost by bike or by foot (no direct access to the roost itself)'; 2 'accessible by bike or by foot (direct access to the roost)' and 3 'accessible by car'.

ther by foot or by motorised transport (i.e. cars), Denmark and the Netherlands have generally better access to roosts (72% and 76% of the roosting sites respectively; Fig. 4.22, 4.23) than Lower Saxony (33%), which is probably explained by the national park regulations in Lower Saxony, which prohibits human access to major parts of the roosting sites (see national protection regimes). Moreover, out of the seven inhabited islands, only two are accessible by cars. Schleswig-Holstein takes an intermediate position as quite many roosting areas (57%), also in parts of the national park, are accessible for e.g. hikers. When regarding access

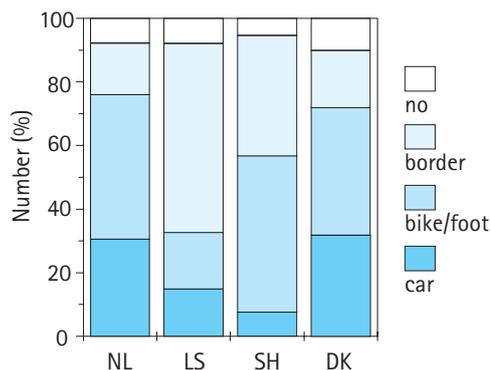


Figure 4.23: Accessibility of high tide roosts in the Wadden Sea. Accessibility was assessed according to expert judgement of national specialists and ranges from 0 'no public access' to 3 'accessible by car' (see Fig. 4.22 for explanation). Countries are DK Denmark, SH Schleswig-Holstein, LS Lower Saxony and NL the Netherlands.

5. Species Accounts

5.1 Introduction

In this chapter, a review of distribution, phenology and habitat use during high tide is presented for all species listed in table 2 (chapter 2.3.2). For each species a distribution map is included (Fig. 5.2), showing the annual mean number of birds at a site (see chapter 2.3.3 for methods). For this purpose, the sites of the smallest level available were used (see Fig. 2.1), which have been chosen to represent the distribution of roosting sites (see chapter 2.3.1). In the Netherlands, two areas are not shown on the scale presented in figure 2.1. These include the Dollard, where bird numbers have been aggregated from the original five sites into one main site, and the mainland coast of Friesland, where 33 sites were aggregated into 10 main sites. In the map, numbers are shown with dots, where dot size is directly (i.e. proportionally) related to the numbers observed.

Phenology is shown in four diagrams (Fig. 5.1), showing seasonal occurrence in Denmark (DK), Schleswig-Holstein (SH), Lower Saxony (LS) and the Netherlands (NL). Given are monthly means, expressed as a percentage from the maximum peak count. In the caption of the graphs this maximum figure is given in brackets for each country separately, allowing an idea which numbers are involved.

The distribution of high tide roosts according to habitat is presented for each country separately (Fig. 5.2, inset). Shown are sand flats (SA, see chapter 2.4.2), salt marshes (MA), inland (IN and IA), beaches/dunes (BE and DU) and artificial structures (DI and AI). Given is the number of birds (annual means, in %) observed during high tide in each habitat type.

In the text, the general patterns found are presented and discussed. In addition, a statement concerning status as a breeding bird or as a migrating and wintering bird is given. These were derived from the recent trilateral breeding bird report (Rasmussen et al. 2000) and the review of waterbirds in the Wadden Sea by Meltofte et al. (1994). Although more recent trilateral reports were available (Rösner et al. 1994, Poot et al. 1996), Meltofte was used because this report presents more general information. Where possible, potential conflicts with human activities are pointed at in the text. However, since it is very difficult to prove a relationship between the numbers of birds observed and the intensity of human activities without specific research (see chapter 6) these statements should be considered indicative and do not represent true assessments (unless a reference is mentioned, referring to a case study).

5.2.1 Cormorant

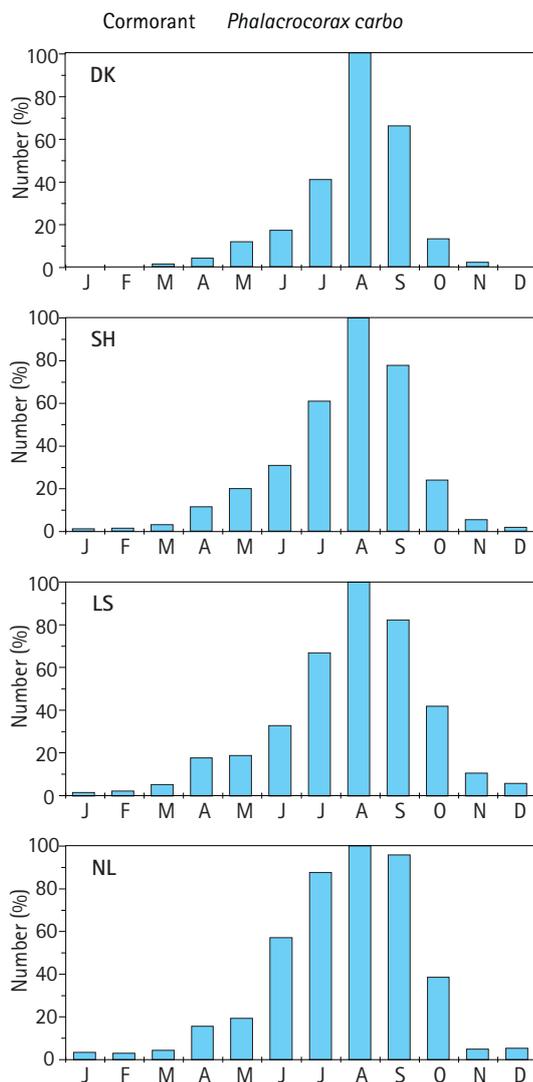
Phalacrocorax carbo

DK: Skarv

D: Kormoran

NL: Aalscholver

Figure 5.1:
Phenology of Cormorant at high tide roosts in Denmark (max. 5,037), Schleswig-Holstein (2,903), Lower Saxony (2,281) and the Netherlands (9,218).



Cormorants breed in increasing numbers in the Wadden Sea of Schleswig-Holstein, Lower Saxony and the Netherlands (Rasmussen et al. 2000, Hälterlein 2001). Besides, large numbers disperse over the area after the breeding season, especially from July until October, in the Netherlands already from June onwards. All countries have peak-numbers in August. During midwinter, the species is virtually absent in most areas. Contrary to, e.g., waders, Cormorants show less distinct movements to high-tide roosts, since they also feed during high tide (Nehls & Gienapp 1999). However, local observations also point at increased hunting activity during low tide, when they fish in gullies on the intertidal mudflats. During evening, the birds gather at communal night roosts.

Large roosts are mainly found in the Dutch and Danish parts of the Wadden Sea, both situated close to the large breeding centres in the Dutch IJsselmeer area and the Danish part of the Baltic. Important sites are, e.g., the islands of Richel, NL, and Griend, NL, as well as the harbour of Den Oever, NL, and a row of electric power cables between Fanø and Esbjerg, DK. In the German Wadden Sea, highest numbers concentrate in the Weser and Elbe estuary, particularly Mellum, LS, Neuwerk, LS, Scharhör, LS and Trischen, SH.

Preferred roosts are often situated at anthropogenic structures (particularly breakwaters in harbours and islands/platforms) and at sand flats and beaches, where risk of disturbance is generally low. In Schleswig-Holstein, many Cormorants also frequent inland water bodies. Since Cormorants are rather susceptible to disturbance, roosts with highest numbers are all linked to uninhabited islands (Richel, Griend, Mellum, Trischen) or offshore anthropogenic structures (Den Oever), where they can roost undisturbed. Of the 13 roosts with an annual mean of >100 individuals, all are within areas designated as SPAs, and 9 have an additional status as nature reserve.

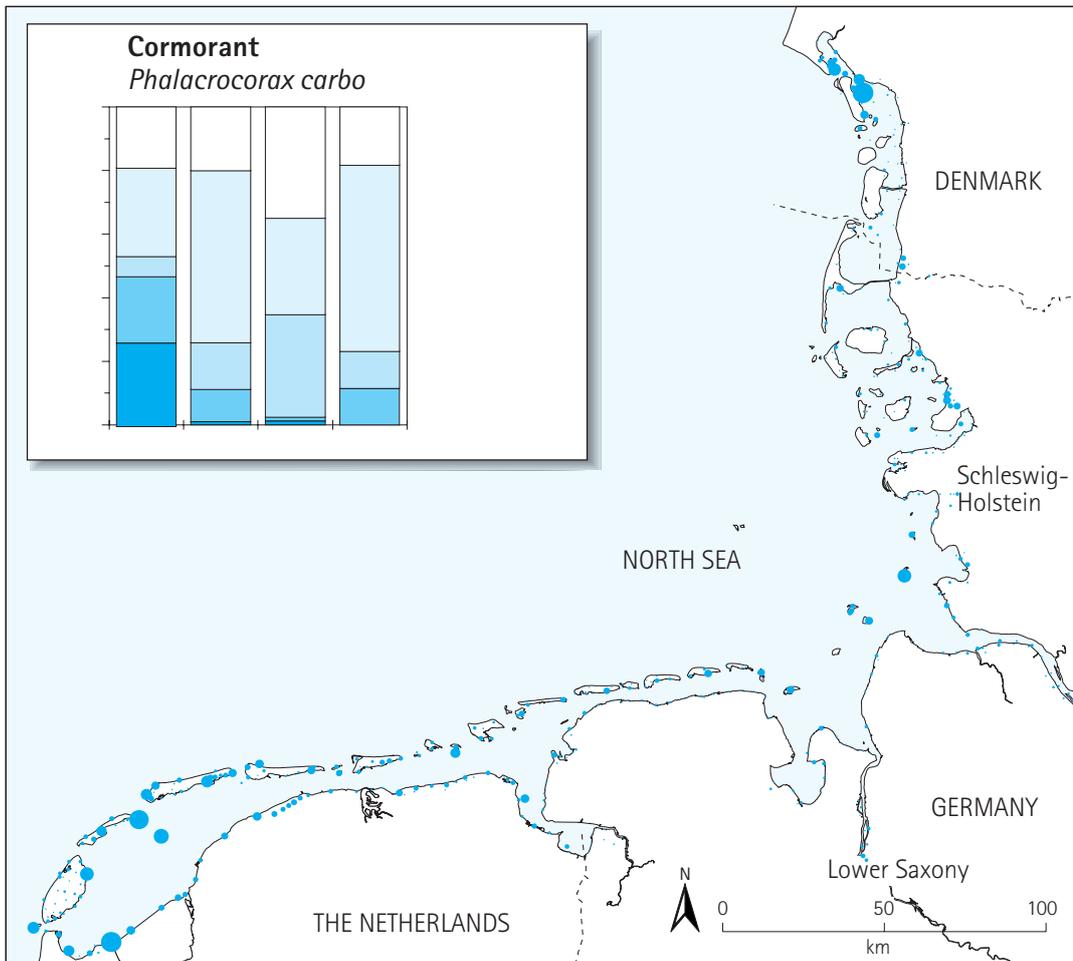


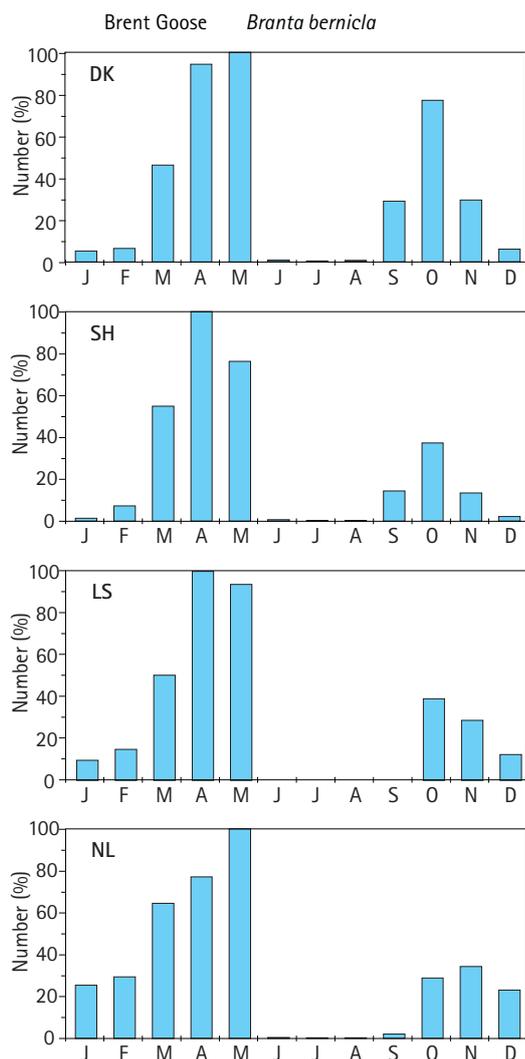
Figure 5.2: Distribution of high tide roosts (map) and habitat distribution of the high tide roosts (inset) of Cormorant in the Wadden Sea.

5.2.2 Brent Goose

Branta bernicla

DK: Knortegås D: Ringelgans NL: Rotgans

Figure 5.3:
Phenology of Brent Goose
at high tide roosts in
Denmark (max. 19,892),
Schleswig-Holstein
(84,092), Lower Saxony
(21,244) and the
Netherlands (86,331).



The Brent Geese staging in the Wadden Sea belong to two distinct geographic populations: the Dark-bellied Brent Goose *B. b. bernicla* from W Siberia and the Light-bellied Brent Goose *B. b. hrota* from Spitsbergen and NE Greenland (Ebbinge et al. 1999, Clausen et al. 1999). Dark-bellied Brent Goose (in short Brent Goose) represents the most common species, whereas small numbers of Light-bellied Brent Geese only occur in the Danish Wadden Sea during autumn migration in September-October. However, during cold winters, Light-bellied Brent Geese have also been observed in considerable numbers in the German and especially Dutch part of the Wadden Sea (Cottaar et al. 1999). Largest numbers of Brent Geese stay in the Wadden Sea in spring (March-May), when nearly the entire population visits the area to accumulate body reserves for departure to the breeding areas (Ebbinge & Spaans 1992). Occurrence in autumn is most pronounced in the Danish Wadden Sea, but usually involves smaller numbers. Wintering is almost confined to the western part of the Dutch Wadden Sea.

The species does not really depend on high tide roosts since it feeds a large part of the year on salt marshes and on improved grassland in inland polders. In autumn, however, larger numbers also exploit *Zostera*, *Ulva* and *Enteromorpha* beds on the intertidal mudflats (Meltofte et al. 1994). Depending on water tables, some of these birds keep on feeding during high tide, but some also switch to salt marshes. The use of inland polders is especially common in the Netherlands during winter (e.g. Koffijberg et al. 1997). Here, they mainly feed on improved grassland, and more occasionally also on fields with autumn-sown cereals, especially along the mainland coast.

Largest numbers of Brent Geese concentrate in four regions, on the Halligen Langeneß, Hooge and Gröde, SH, on Texel, Ameland and Terschelling, NL, and along the mainland coast of Friesland, NL. These sites hold annual means > 1,000 individuals. Here, salt marshes (Halligen, Ameland, coast of Friesland, Terschelling) and improved grassland in inland polders (Texel, Ameland, Ter-

schelling) compose the main feeding habitat. Salt marshes are all within the borders of SPA sites, and the important sites at the islands are often also designated as national nature reserves. However, large numbers feed in inland polders in the Netherlands (islands as well as mainland coast) which do not have a protected status at all (in fact, of all birds recorded, about 79% is concentrated in SPAs). The only exception is the reserve

pressed by a decrease in grazing pressure on salt marshes in Lower Saxony and the mainland of Schleswig-Holstein (review in van Nugteren 1997), may have an adverse impact on the use of salt marshes on a longer term. However, the extent to which carrying capacity is reduced highly depends on other (geomorphological) characters of the salt marsh as well (Esselink 2000, Stock & Hofeditz 2000, Borchach-Jaene 2001).

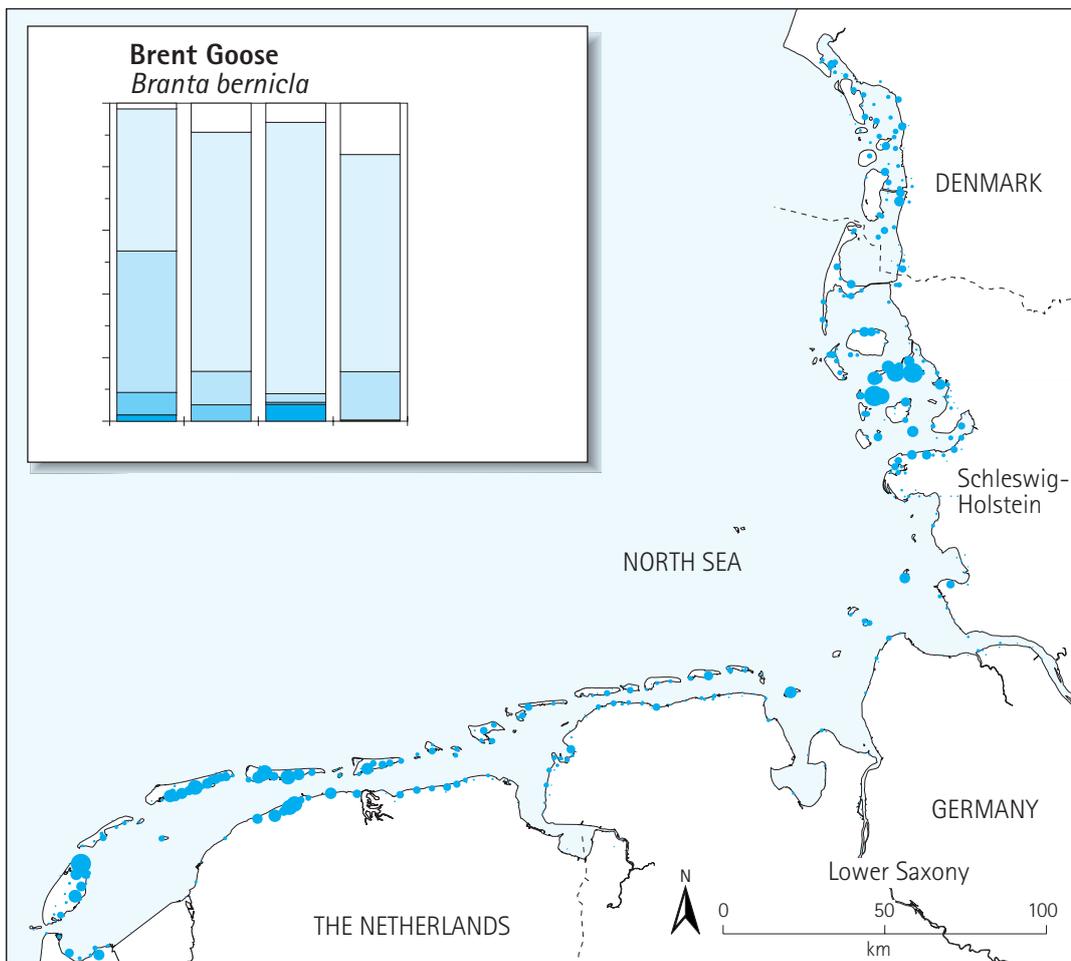


Figure 5.4: Distribution of high tide roosts (map) and habitat distribution of the high tide roosts (inset) of Brent Goose in the Wadden Sea.

Zeeburg at the northeastern tip of Texel, which was especially designated to accommodate Brent Geese (Spaans & Postma 2001).

Conflicts with agriculture, arising when large numbers feed on improved grassland or autumn-sown cereals have been partly tackled in the Dutch Wadden Sea, by providing special management in goose reserves (polders at Terschelling, Ameland and recently also Schiermonnikoog; Laursen 2002). A similar programme operates at the Halligen in Schleswig-Holstein (Laursen 2002). Since especially cattle-grazed salt marshes provide suitable feeding resources and support high numbers of Brent Geese (e.g. Bos et al. 2002), changes in agricultural use of the salt marsh, currently ex-

Furthermore, wind turbines impose an important threat. Studies in Lower Saxony have shown avoidance distances of about 600 m for White-fronted Geese and Barnacle Geese (Kruckenberg & Borchach-Jaene 1999, Kowallik & Borchach-Jaene 2001). Studies in Schleswig-Holstein have shown that Brent Geese are highly susceptible to aircraft and especially helicopters, as well as a frequent appearance of tourists (e.g. Stock 1993, 1994, Stock et al. 1998).

5.2.3 Shelduck

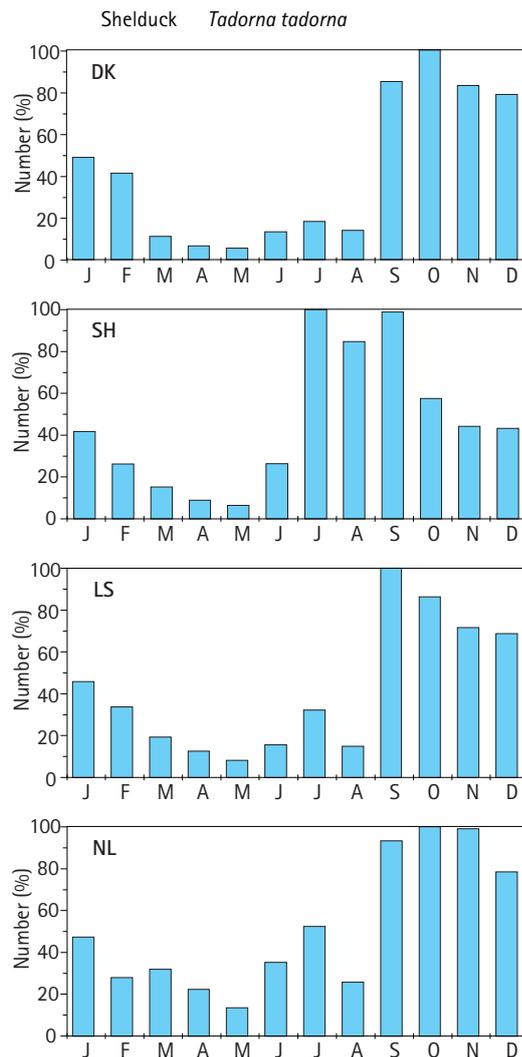
Tadorna tadorna

DK: Gravand

D: Brandente

NL: Bergeend

Figure 5.5:
Phenology of Shelduck at high tide roosts in Denmark (max. 60,963), Schleswig-Holstein (96,377), Lower Saxony (67,983) and the Netherlands (51,112).



Shelduck is a common breeding bird in all parts of the Wadden Sea, with highest numbers breeding on the islands (Rasmussen et al. 2000). Phenology differs between the countries, in particular in Schleswig-Holstein. Here, numbers observed mainly belong to the large moulting concentration in the Elbe estuary, where up to 200,000 individuals have been observed during primary-moult in July-August (Meltofte et al. 1994, Kempf 2001). However, most of these roost so far offshore that they are not all represented in the counts presented here (and do not use high tide roosts). The moulting site attracts birds from the entire North Sea area as well as the Baltic. From September onwards, when moult is finished, the birds disperse over the other parts of the Wadden Sea and usually reach peak numbers between September-December. The species feeds extensively on intertidal mudflats (Meltofte et al. 1994) and spends high tide mainly on the salt marshes, and more locally also on sand flats (Denmark) and at dikes (the Netherlands). In Denmark, a large concentration is found in the embanked Margrethe Kog.

Apart from the large numbers found in the outer Elbe of Lower Saxony (Scharhörn) and Schleswig-Holstein (salt marsh at Dieksanderkoog-Süd, Trischen, with an annual mean up to 9,300 birds), Shelduck show a rather evenly distribution over the Wadden Sea. At most sites, no special threats are known (except for possible local impact of outdoor recreation and coastal fisheries), and all important concentrations are within SPA bound-

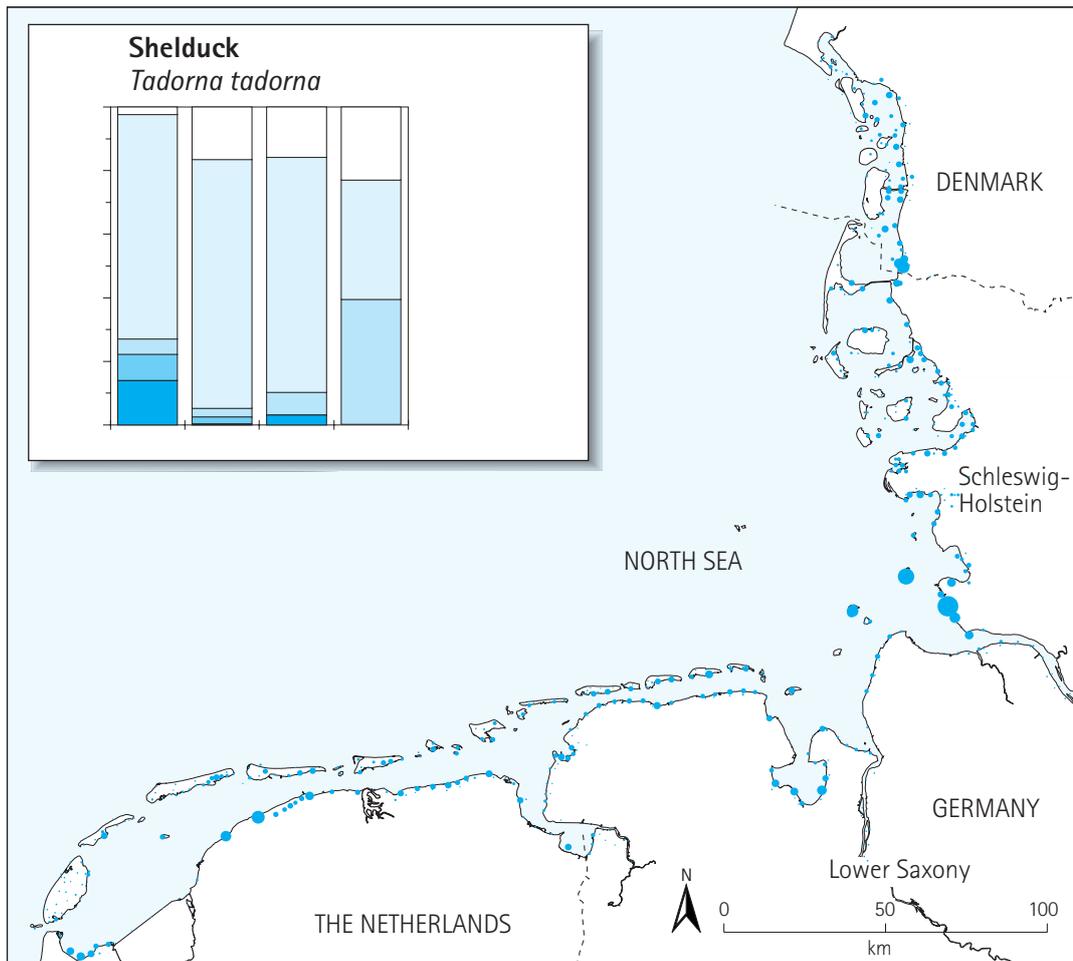
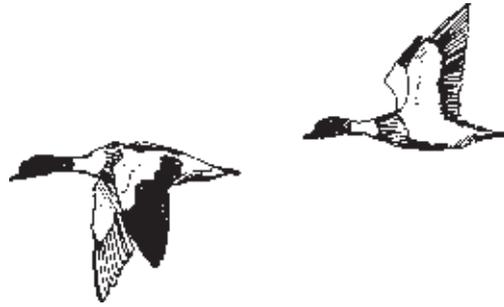


Figure 5.6:
Distribution of high tide roosts (map) and habitat distribution of the high tide roosts (inset) of Shelduck in the Wadden Sea.

aries (98% of all birds). However, concerning the major sites in the Elbe estuary, threats are imposed by the oil-spilling platform Mittelplate 10-20 km to the north, the high number of ship movements a few kilometres to the west (the Elbe estuary is one of the busiest shipping routes in the world, a lot of oil and dangerous cargo is transported), and disturbance by small shrimp vessels.

The only possibility to improve the quality of the moulting area is to reduce disturbance by fishing boats. A voluntary agreement with fishermen, in which they accept to keep out of the moulting area from July to September was implemented in 2003 might solve the problem.

5.2.4 Wigeon

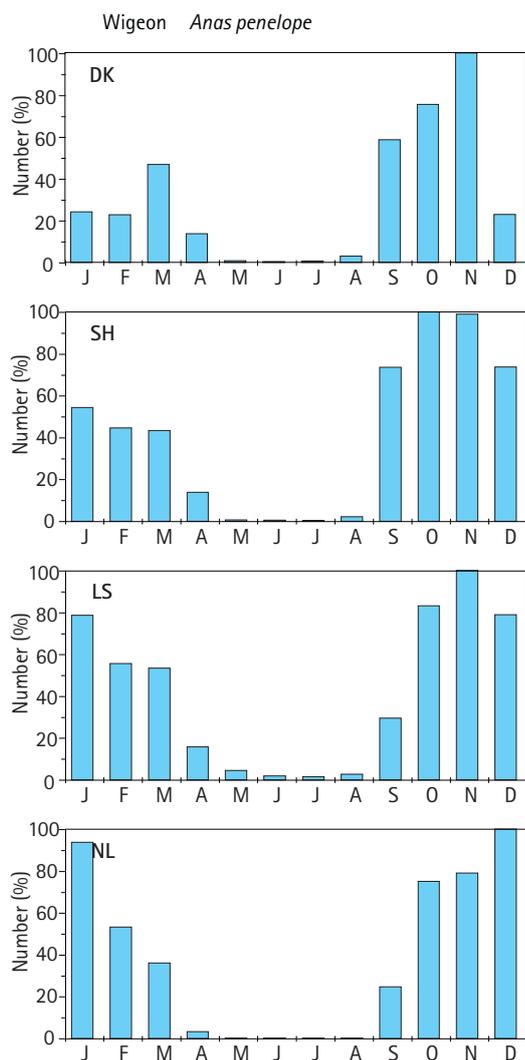
Anas penelope

DK: Pibeand

D: Pfeifente

NL: Smient

Figure 5.7: Phenology of Wigeon at high tide roosts in Denmark (max. 55,493), Schleswig-Holstein (109,950), Lower Saxony (41,585) and the Netherlands (83,319).



The Wigeon is mainly present in the Wadden Sea as a non-breeding bird (Meltofte et al. 1994). Largest numbers are observed in autumn, especially from October to November. Later in autumn and winter, most birds move to the Dutch part of the Wadden Sea, where numbers usually peak in December and January. Wigeons do not show pronounced tidal movements, but have been included here as they also feed on *Zostera* beds on the intertidal mudflats in autumn and congregate around high tide roosts during high tide (Meltofte et al. 1994). Most roosting birds stay in salt marshes, which also constitutes a favoured feeding habitat. In Schleswig-Holstein and notably Denmark, large flocks are also observed in polders and embanked areas. Visits to inland areas are also known to occur at night, when large numbers feed at inland pastures (Meltofte et al. 1994).

Sites which attract large numbers of Wigeon are mainly found in Denmark and Schleswig-Holstein. Especially Margrethe Kog DK (two sites) and Rickelsbüller Koog SH hold large numbers of Wigeon (annual mean 1,600-4,600 birds). Elsewhere, the Halligen, islands and mainland coast at Beltringharder Koog have large flocks of Wigeon (Langeneß, 3,100). In Lower Saxony, major sites are found at the lower Elbe, Jadebusen and Dollard. In the Dutch part, the Dollard is the main staging area in the western half of the Wadden Sea (annual mean 3,800). Elsewhere in the Netherlands, concentrations occur at the islands (except Vlieland) and along the mainland coast of Friesland.

Many of the sites holding high numbers of Wigeon are within SPA sites (90% of the birds). Potential sources of disturbance are mainly hunting and recreational activities. None of the larger sites, holding on average >1,000 individuals, is currently subject to extensive disturbance (except the Halligen in SH where Wigeons are hunted part of the year), and most of them are situated within

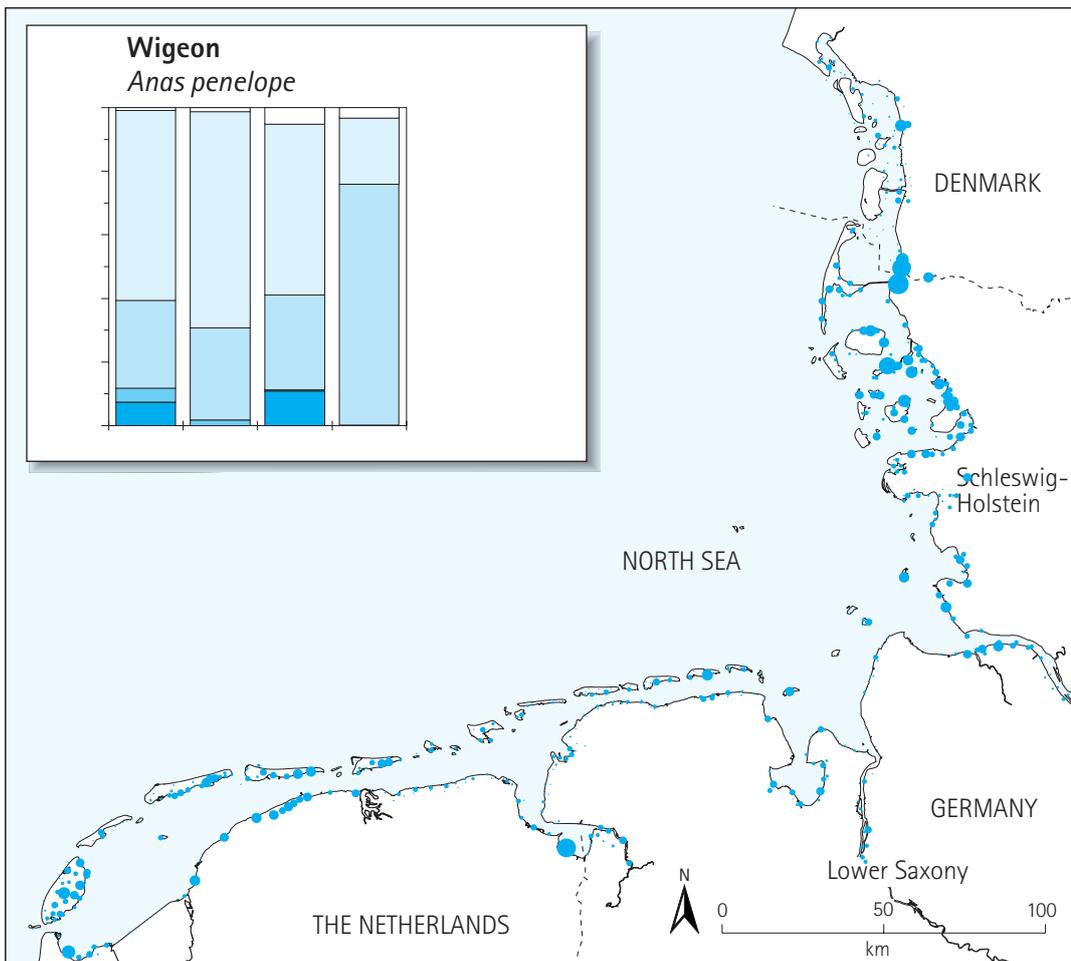


Figure 5.8: Distribution of high tide roosts (map) and habitat distribution of the high tide roosts (inset) of Wigeon in the Wadden Sea.

nature reserves as well. However, nocturnal feeding in pastures may well be regarded as response to disturbance during daytime. Moreover, hunting in the Danish Wadden Sea has probably reduced numbers of Wigeon here, especially along the mainland coast (Ribe, Tøndermarsken) where Wigeon are heavily hunted (Laursen 1985). In re-

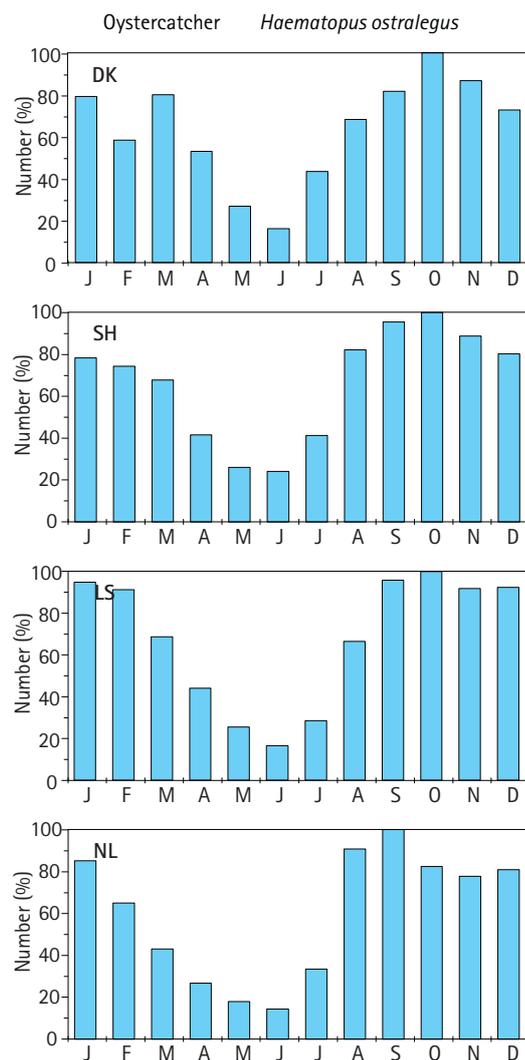
cent years, numbers of Wigeon have increased along the Danish mainland coast as a response to new hunting-free areas, but in late autumn, when Wigeon favour grassland to feed, hunting in the polders does not allow the birds to stay. As a result, the birds concentrate in the embanked Margrethe Kog, where hunting is prohibited.

5.2.5 Oystercatcher

Haematopus ostralegus

DK: Strandskade D: Austernfischer NL: Scholekster

Figure 5.9: Phenology of Oystercatcher at high tide roosts in Denmark (max. 44,170), Schleswig-Holstein (135,303), Lower Saxony (159,396) and the Netherlands (195,362).



Oystercatcher breed and winter in large numbers in the Wadden Sea (Rasmussen et al. 2000, Meltotte et al. 1994). The seasonal pattern is rather uniform, with largest numbers present during autumn and winter. Peak counts are made in November, in the Dutch Wadden Sea in September. Prolonged cold-spells often result in massive south bound movements (e.g. Hulscher 1989). Most high tide roosts are situated on salt marshes. Especially in the Dutch and Danish Wadden Sea, roosts are also located on sandy areas, like beaches and sand flats. Inland roosting is (except for extremely high tides) quite rare, and mainly occurs in the Dutch Wadden Sea. In the Dutch Wadden Sea, distribution during low tide is especially associated with the occurrence of mussel beds (Ens et al. 1993). Oystercatchers have shown a 35% reduction in numbers since the mid 1980s in the Dutch part of the Wadden Sea. This is thought to be associated with depleted mussel stocks (Smit et al. 2000). A similar decline was found in Schleswig-Holstein (Günther & Rösner 2000).

Sites with the largest flocks of Oystercatcher are mainly situated in the Netherlands and in Lower Saxony, including the Elbe estuary. Seven sites have an annual mean of > 5,000 individuals: Griend, NL, Balg/Schiermonnikoog, NL, salt marsh of Butjadingen, LS, Sandplate/Memmert LS, Posthuiswad/Vlieland NL, Baltrum Heller/Baltrum LS and Trischen SH. Most sites are within SPA borders (93% of all birds). Main risks of disturbance are probably represented by recreational outdoor activities. Currently, the main constraint is probably imposed by deteriorating food stocks caused by commercial mussel and cockle fisheries (Piersma & Koolhaas 1997).

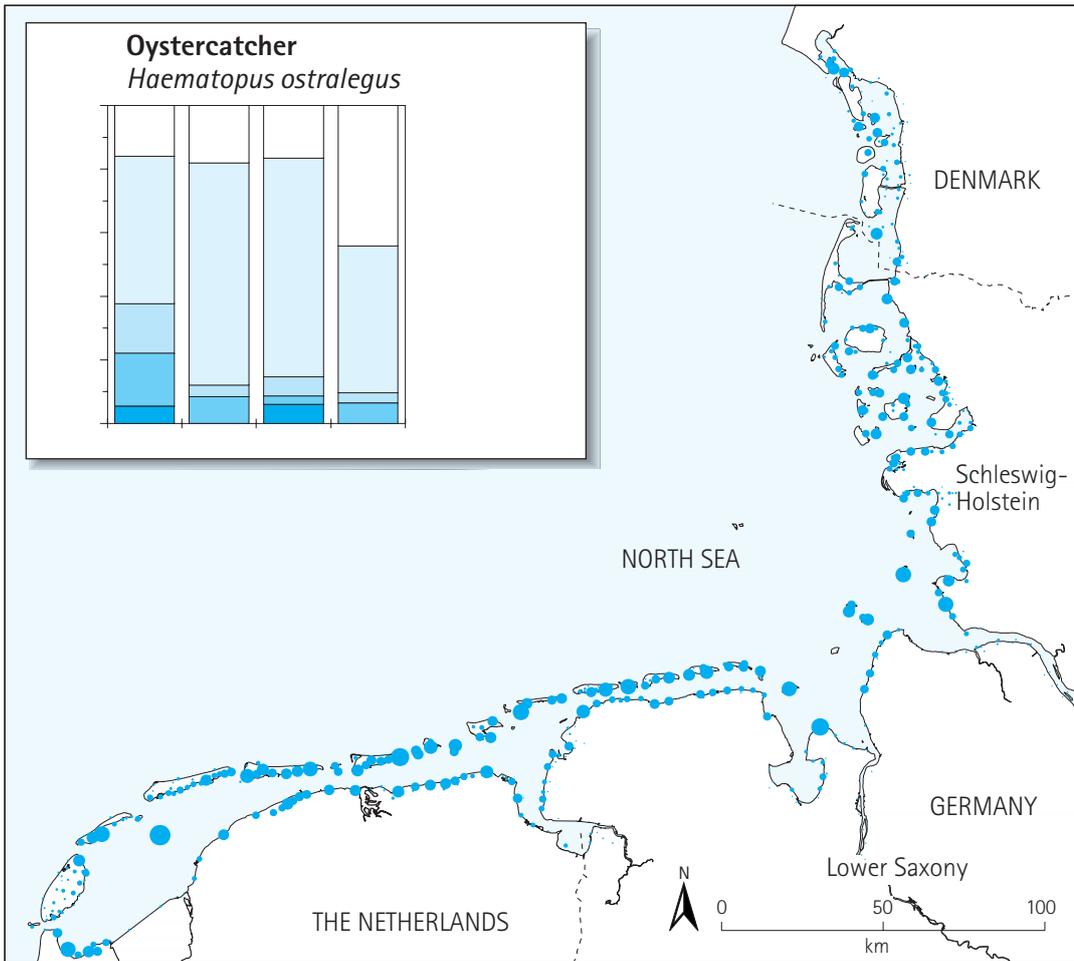


Figure 5.10: Distribution of high tide roosts (map) and habitat distribution of the high tide roosts (inset) of Oystercatcher in the Wadden Sea.

5.2.6 Avocet

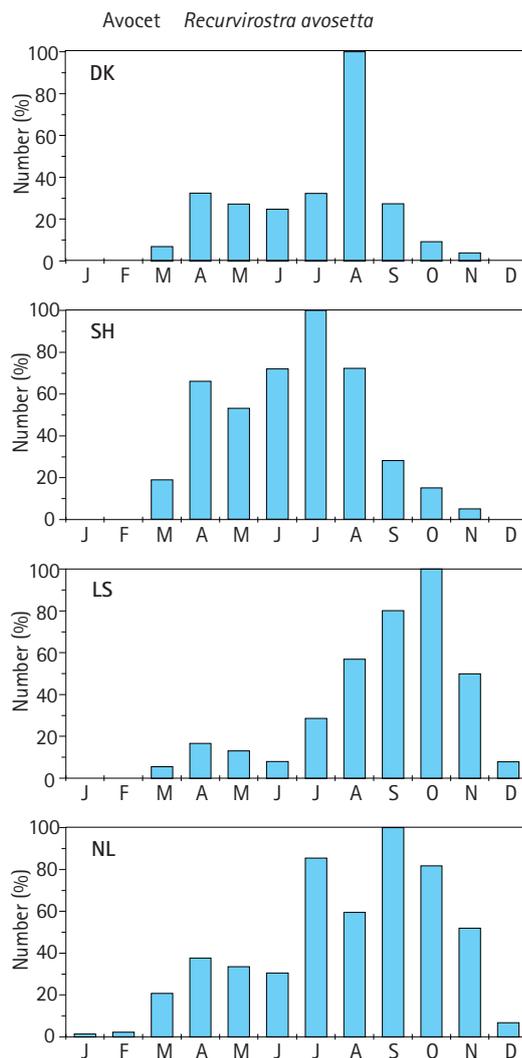
Recurvirostra avoetia

DK: Klyde

D: Säbelschnäbler

NL: Kluut

Figure 5.11:
Phenology of Avocet at
high tide roosts in
Denmark (max. 4,216),
Schleswig-Holstein
(8,646), Lower Saxony
(20,346) and the
Netherlands (15,508).



Avocets breed in all Wadden Sea countries (Rasmussen et al. 2000) and are also observed in large numbers prior to the breeding season and in late summer and autumn (Meltøfte et al. 1994). Phenology differs somewhat between the countries. Lower Saxony and the Netherlands have largest numbers from July to November, whereas in Schleswig-Holstein and Denmark, numbers peak already earlier in summer. These birds probably mainly refer to local breeding birds and post-breeding moulting concentrations (Meltøfte et al. 1994, Dietrich & Hötter 1991), although the Danish Wadden Sea is also supposed to support (moulting) birds from the Baltic. Moulting concentrations also occur in Lower Saxony (Jadebusen) and the Netherlands (Dollard). The Jadebusen has been the most important post-moulting site in the Wadden Sea up to November. These birds gather here before leaving for the wintering grounds. Main habitats used during high tide are salt marshes, although in Schleswig-Holstein in autumn many birds roost at the embanked brackish or saltwater lakes and reservoirs.

Avocets are mainly distributed along the mainland coast, which is probably explained by their preference for muddy tidal flats and gullies with soft sediment (Ens et al. 1993). Only few areas in Lower Saxony and the Netherlands hold very large concentrations (annual mean >500/month): Vorland Süd/Jadebusen, Norderseefeld/Jadebusen and Vorland Nord/Dollart (Lower Saxony) and Bildtpollen and Dollard (Netherlands). Jadebusen is a well-known moulting site; the other areas also support large breeding colonies. Concentrations at Margrethe Kog and the area between Sylt and Rømø belong to a large moulting site as well (Dietrich & Hötter 1991).

Most Avocets (96%) are found within SPA areas. Main conflicts might arise with recreational outdoor activities, which is high at the sites around the Jadebusen.

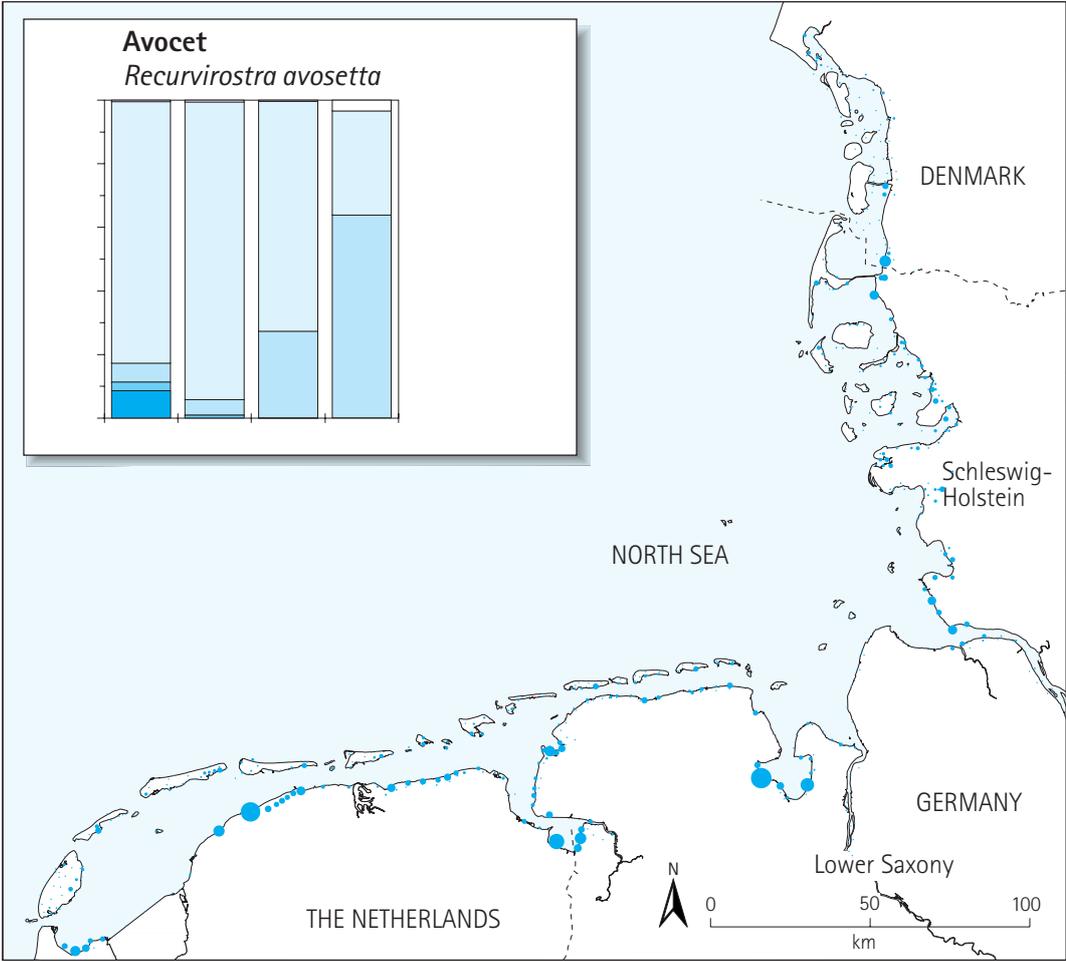


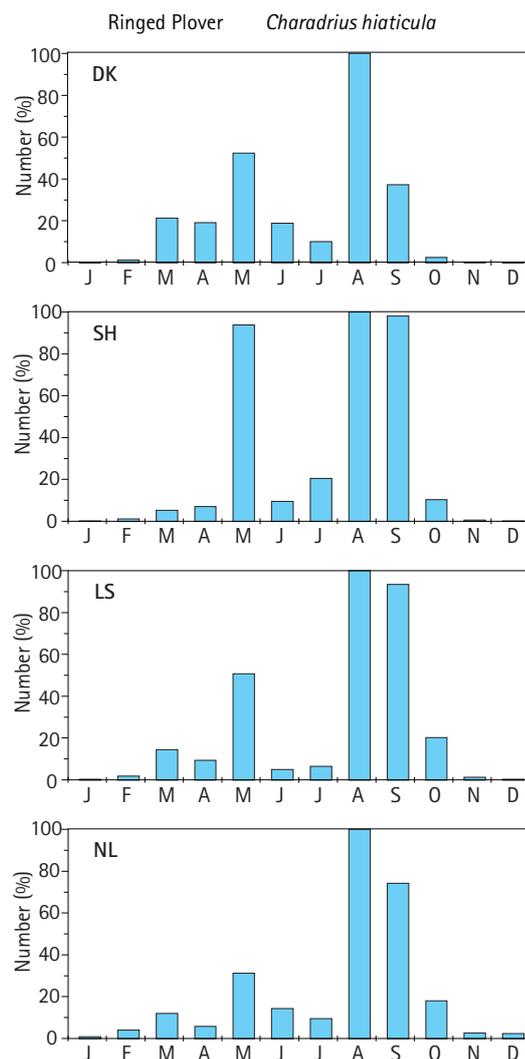
Figure 5.12: Distribution of high tide roosts (map) and habitat distribution of the high tide roosts (inset) of Avocet in the Wadden Sea.

5.2.7 Ringed Plover

Charadrius hiaticula

DK: Stor Præstekrave D: Sandregenpfeifer NL: Bontbekplevier

Figure 5.13:
Phenology of Ringed Plover
at high tide roosts in
Denmark (max. 911),
Schleswig-Holstein
(10,612), Lower Saxony
(6,336) and the
Netherlands (5,228).



Ringed Plovers are regular breeding birds in small numbers in the Wadden Sea. These birds belong to the northern part of the subsp. *hiaticula*, which also breeds in southern Scandinavia and the Baltic and migrates in March and April (Meltofte et al. 1994). Much larger numbers of the arctic-breeding population of subsp. *tundrae* are observed during their stop-over between the West-African wintering and the arctic breeding areas. Migration of these birds mainly occurs in May and August-September. The passage in May is most pronounced in Schleswig-Holstein, especially along the coast of Dithmarschen (e.g. Dieksanderkoog), and Denmark. In autumn, distinction between the two populations is less clear. Preferred roosts are rather sandy areas, like beaches and sand flats. Especially in May, large numbers also stay at salt marshes and also in the Eider-estuary, where they feed on muddy tidal flats in the brackish zone of the river mouth, on the inner side of the storm barrage. Smaller flocks are observed at inland sites. These include semi-natural wetlands as well as sparsely vegetated arable fields.

Ringed Plovers are very much dispersed over the entire Wadden Sea and only few areas are favoured. Concentrations (annual mean >100) are usually present at the salt marshes of Dieksanderkoog-Süd, Kaiser Wilhelm Koog and Neufeld Koog, SH, as well as Trischen, SH, Emmapolderwad, NL, and salt marshes between Schillig and Hooksiel, LS. Nearly all roosts (about 95% of the birds) are protected as SPA sites. As concentrations are generally small, potential conflicts with human activities are difficult to assess. Most of the important sites mentioned above (7 out of 9) have little or no recreational activities. Recently, a large roost has also established at the west coast of Fanø, in an area with heavy recreational pressure.

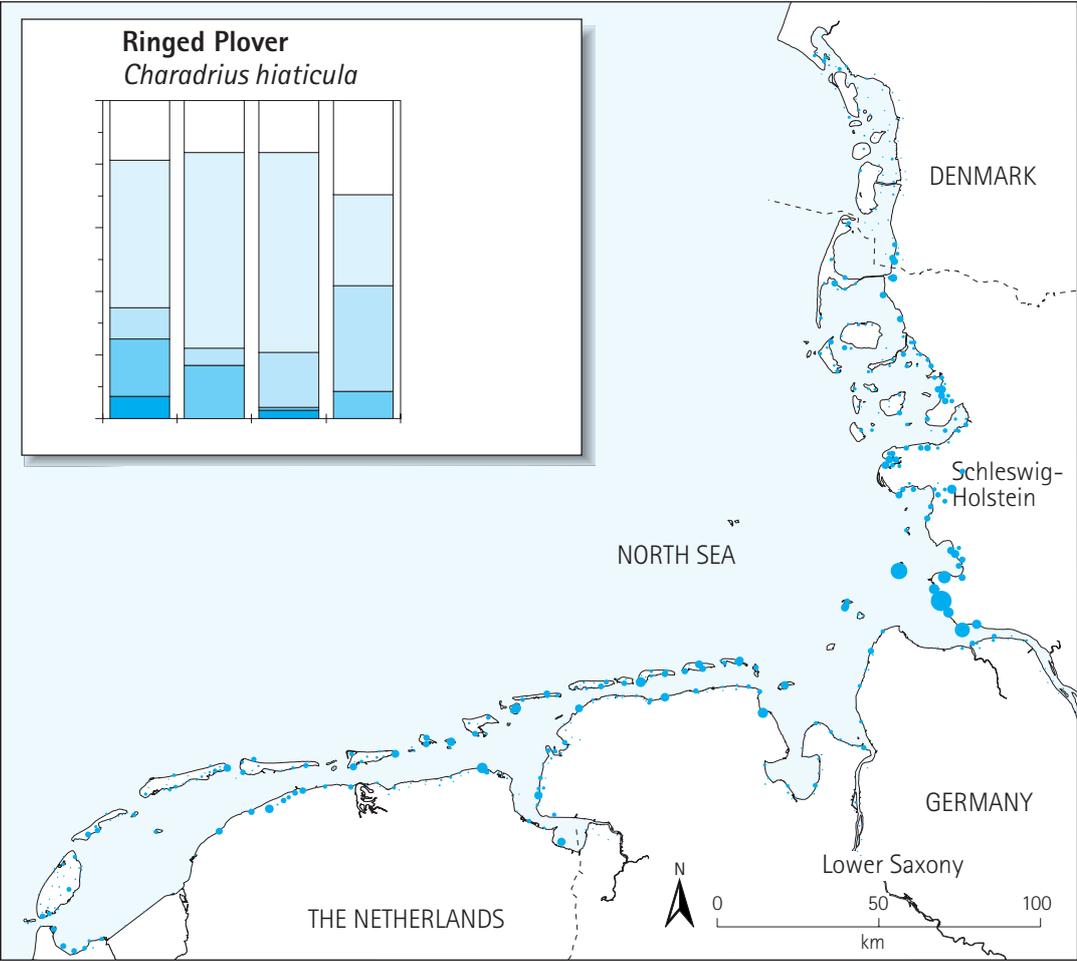
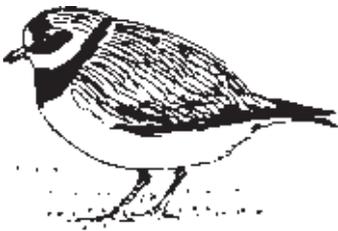


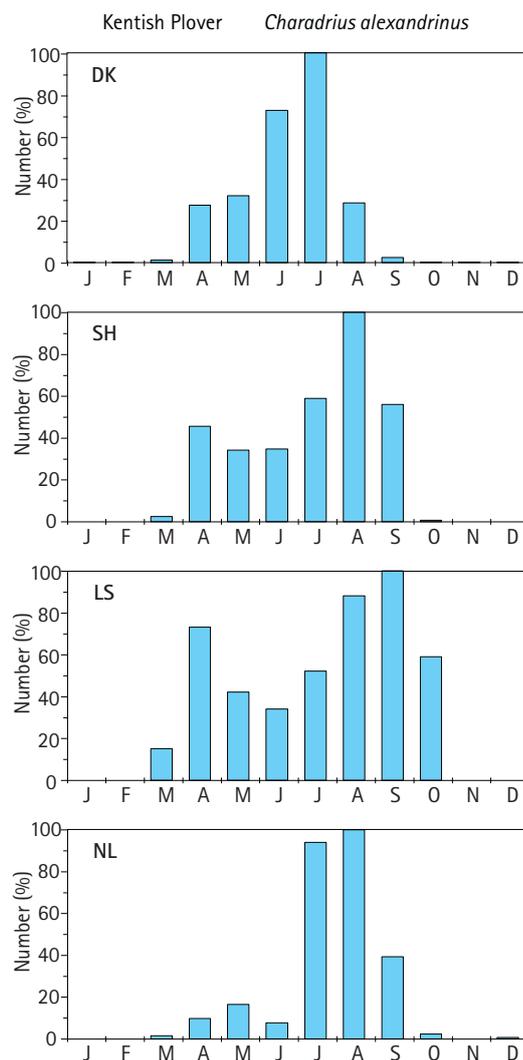
Figure 5.14: Distribution of high tide roosts (map) and habitat distribution of the high tide roosts (inset) of Ringed Plover in the Wadden Sea.

5.2.8 Kentish Plover

Charadrius alexandrinus

DK:Hvidbrysted Præstekrave D:Seeregenpfeifer NL:Strandplevier

Figure 5.15:
Phenology of Kentish
Plover at high tide roosts
in Denmark (max. 88),
Schleswig-Holstein (352),
Lower Saxony (100) and
the Netherlands (355).



Kentish Plovers are present in the Wadden Sea from April to early October. They mainly represent the local breeding population (Meltofte et al. 1994). Highest numbers are usually recorded from July to September. Peak counts are not synchronous and vary from July (Denmark), August (Schleswig-Holstein) to September (Lower Saxony). The Netherlands have only small numbers before July and notes pronounced occurrence from July to September. Similar to its breeding habitat, favoured sites are sand flats and beaches. Especially in the Netherlands, the main roosting habitat is represented by salt marshes (although only small numbers involved). In Schleswig-Holstein and Denmark, also inland sites are visited.

The Kentish Plover is extremely scarce throughout the Wadden Sea. Distribution is highly similar to that of the breeding population (Rasmussen et al. 2000) with largest concentrations on sandbars in the western part of Eiderstedt, SH, particularly St. Peter and Westerhever Sand. Other sites with high numbers are Westpunt Ameland, NL, and Dieksanderkoog-Süd, SH. However, only small numbers are involved here. Nearly all birds (95%) stay within the SPA zone. Compared to other species, major numbers roost at sites frequented by many tourists, e.g. the beaches around St. Peter, SH. Tourist pressure has an obvious negative impact on reproduction of breeding birds as birds are disturbed very easily (e.g. Stock 1994, Tulp 1998).

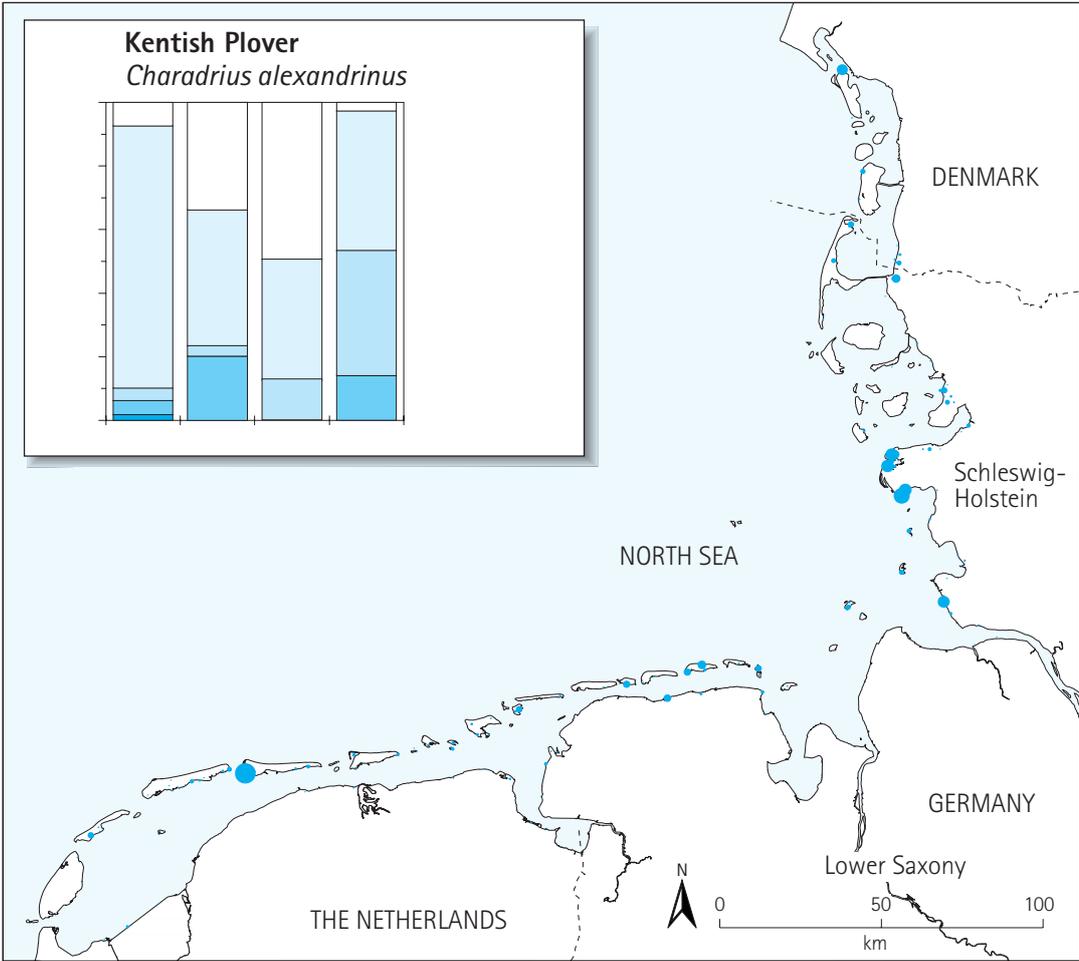


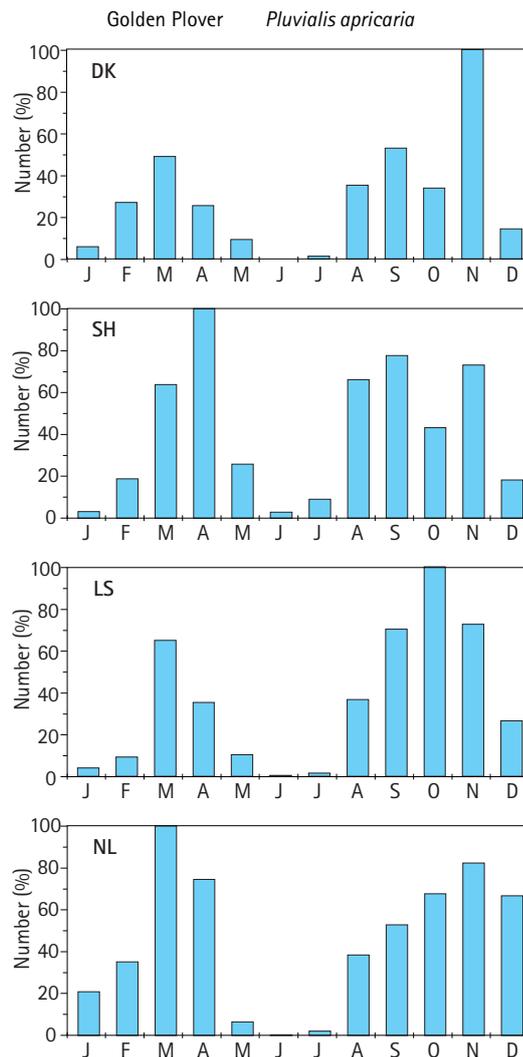
Figure 5.16: Distribution of high tide roosts (map) and habitat distribution of the high tide roosts (inset) of Kentish Plover in the Wadden Sea.

5.2.9 Golden Plover

Pluvialis apricaria

DK: Hjelje D: Goldregenpfeifer NL: Goudplevier

Figure 5.17:
Phenology of Golden
Plover at high tide roosts
in Denmark (max.
110,622), Schleswig-
Holstein (26,388), Lower
Saxony (41,181) and the
Netherlands (33,284).



The Golden Plover is numerous during spring and autumn migration and smaller numbers stay also during winter. This species favours improved grassland as well as arable land at inland sites, and therefore the largest concentrations are found behind the dikes. Only in Schleswig-Holstein, high numbers occur also at salt marshes during high tide. The numbers staying inland are only partly taken into account during the counts. A study in Lower Saxony showed that Golden Plover feed in the intertidal area mainly in August, but shift increasingly to inland feeding sites from September onwards, and then adjusting to a day and night rhythm (Ketzenberg & Exo 1996). Highest numbers are observed in March-April and August-November. Quite many also stay in the Netherlands until December. However, phenology is not synchronised. In the Netherlands and Schleswig-Holstein, peak numbers are observed during spring migration in March and April respectively, whereas Denmark and Lower Saxony hold most birds in autumn.

Distribution of Golden Plover has a stronghold at Ny Frederikskog/Margrethe Kog, DK. Sites in these areas hold by far the largest numbers (annual mean 1,200-7,400 birds). Elsewhere, peak occurrence is recorded at Noorderleeg, NL, Rickelsbüller Koog (which is close to Ny Frederikskog/Margrethe Kog), Beltringharder Koog, the coast of Eiderstedt and the islands Sylt and Amrum, SH. Besides, several polders at the Unterelbe, LS, and Dollard, NL support large numbers of Golden Plover. Since many important roosts are inland,

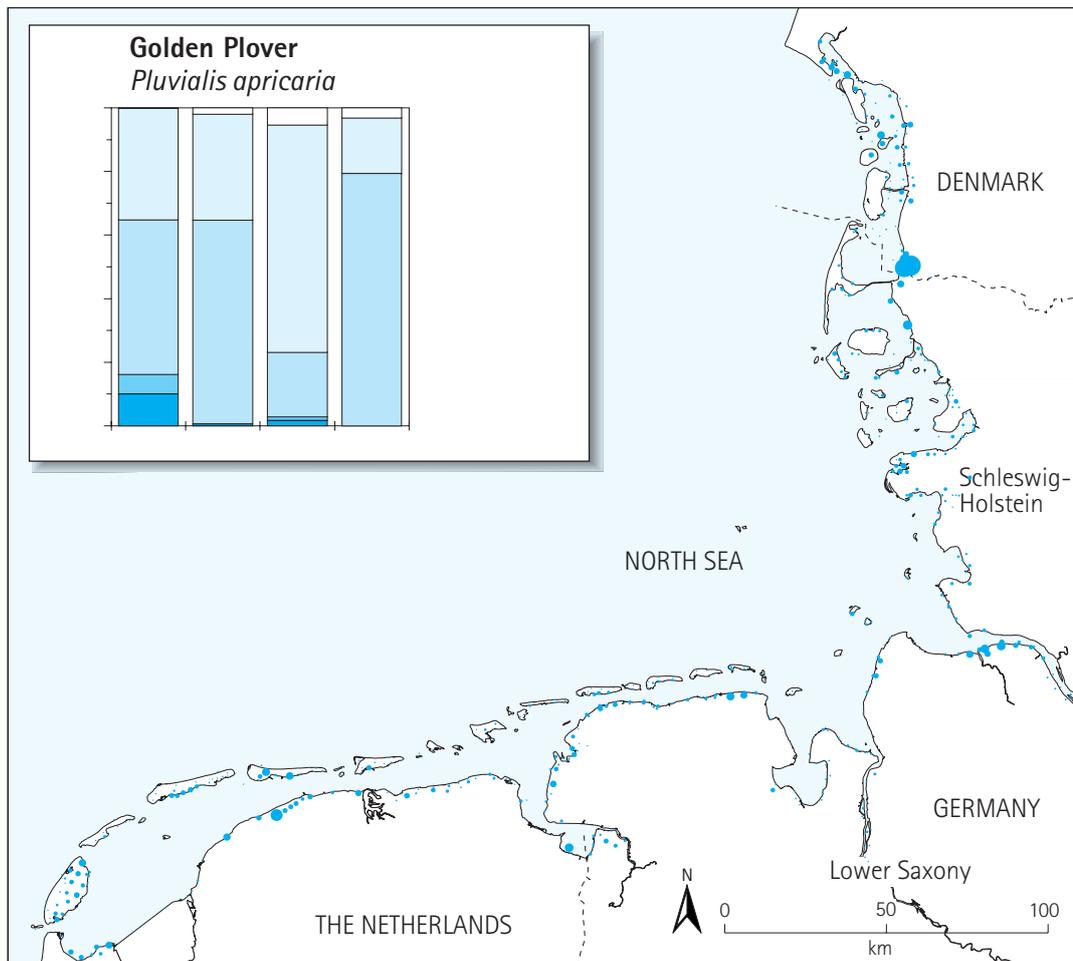


Figure 5.18: Distribution of high tide roosts (map) and habitat distribution of the high tide roosts (inset) of Golden Plover in the Wadden Sea.

Golden Plover has a relatively low proportion of birds (about 88%) which stay within SPA boundaries. Also many birds are roosting outside the National Parks zones in Lower Saxony and Schleswig-Holstein. Potential human interference is to be expected from agriculture, hunting and wind farms. Variation in hunting pressure has shown a

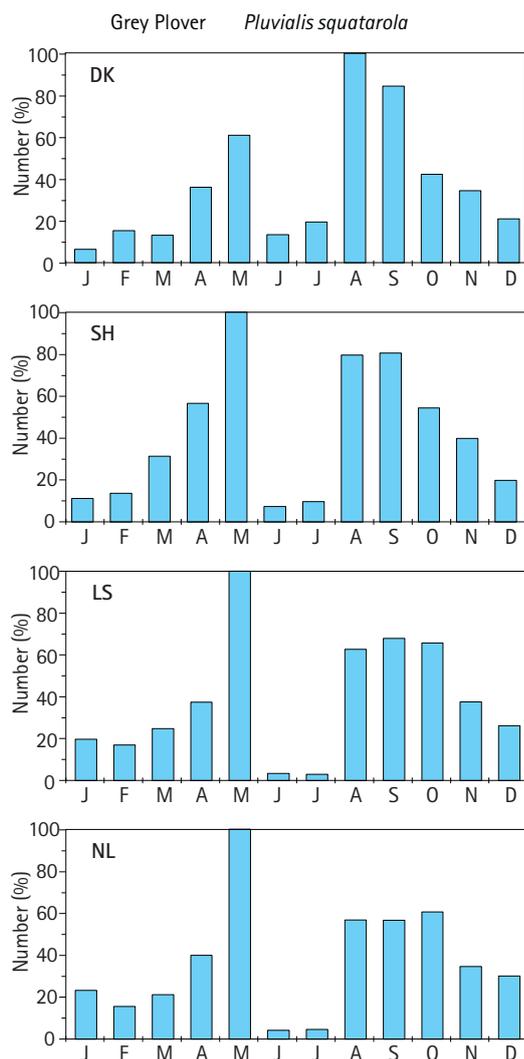
pronounced impact on the distribution of Golden Plovers. As hypothesised by Rasmussen (1994) and Jukema et al. (2001), many Golden Plovers nowadays stay in autumn in Denmark (where hunting was closed in 1982) to complete moult, and arrive later in autumn at their staging areas in the Netherlands.

5.2.10 Grey Plover

Pluvialis squatarola

DK: Strandhjelje D: Kiebitzregenpfeifer NL: Zilverplevier

Figure 5.19:
Phenology of Grey Plover
at high tide roosts in
Denmark (max. 12,027),
Schleswig-Holstein
(34,630), Lower Saxony
(37,819) and the Nether-
lands (46,969).



Grey Plover is numerous during spring and autumn migration, with small numbers in winter and also varying numbers of immature birds staying during summer (Meltofte et al. 1994). Numbers build up in March and April, reaching a peak during spring migration in May. During this time of the year highest numbers are present in Schleswig-Holstein, Lower Saxony and the Netherlands. Autumn migration starts in August and is more pronounced in Denmark (which has highest numbers in August) and Schleswig-Holstein. In the Netherlands and Lower Saxony, numbers in August-October vary only slightly. During high tide, most Grey Plovers frequent salt marshes and sand flats. In Denmark, the area around Margrethe Kog supports high numbers inland. In salt marshes, Grey Plovers are also regularly observed to roost on the wooden barriers of the sedimentation works.

Although Grey Plovers disperse over all parts of the Wadden Sea, they concentrate at a few sites. These are, e.g., Spiekeroog Ost, LS, (annual mean 2,800), Trischen, SH, (2,100) and Scharhör Sand, NS, (1,600). Other sites with large numbers are mainly situated in the Netherlands and Lower Saxony, especially at some of the islands. In Schleswig-Holstein and Denmark, highest numbers are counted at Dieksanderkoog, SH, and at Keldsand, south of Fanø, DK. Nearly all Grey Plovers stay within SPA boundaries. In general, disturbance levels at these sites are considered low, although locally, frequent occurrence of outdoor recreation might displace birds from their regular roosts.

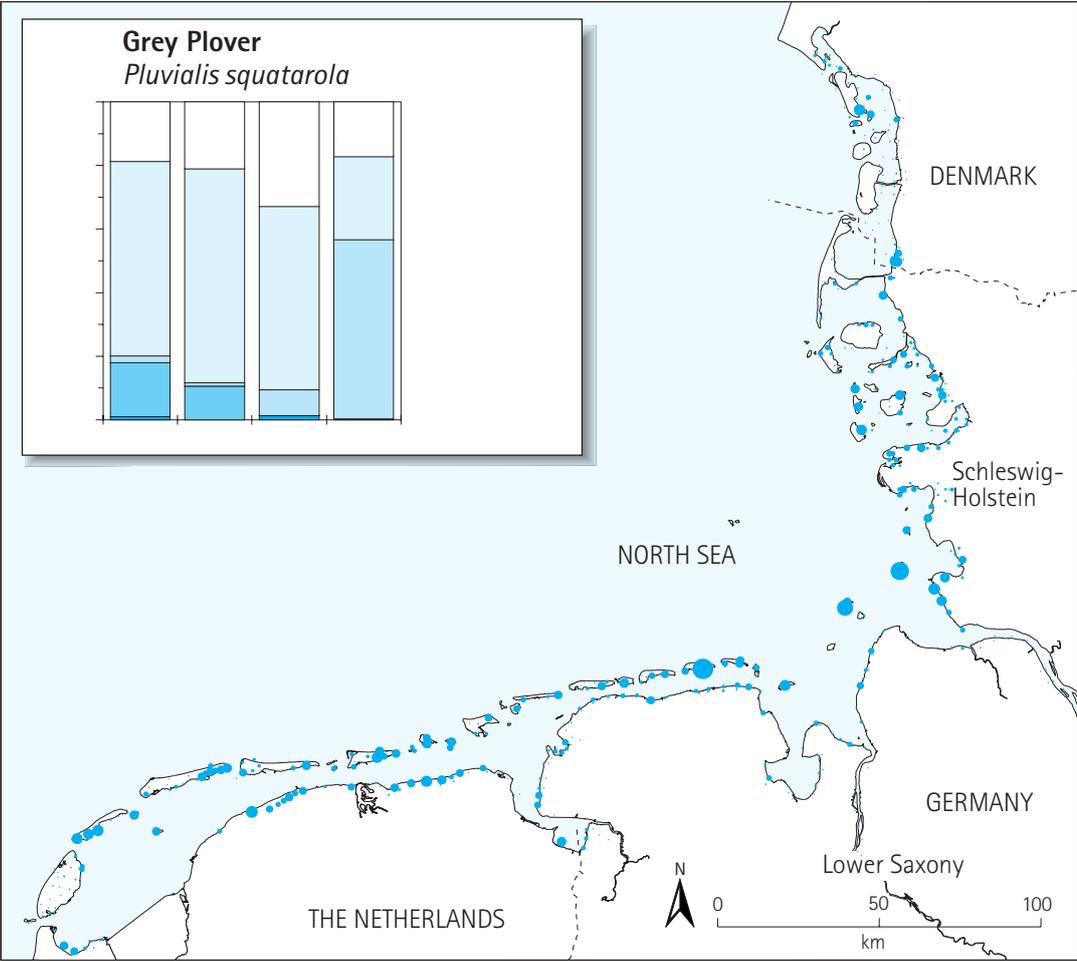


Figure 5.20: Distribution of high tide roosts (map) and habitat distribution of the high tide roosts (inset) of Grey Plover in the Wadden Sea.

5.2.11 Red Knot

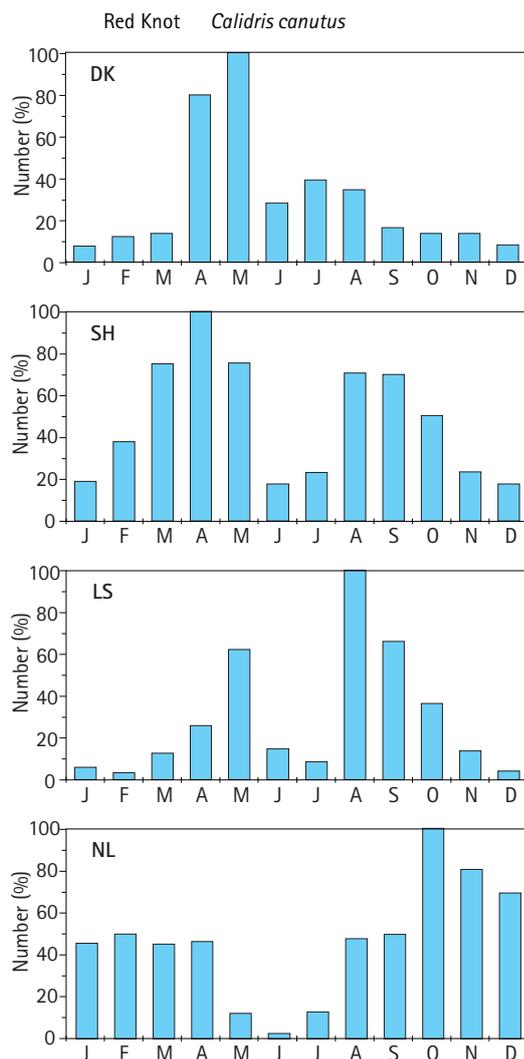
Calidris canutus

DK: Islandsk Ryle

D: Knutt

NL: Kanoet

Figure 5.21:
Phenology of Red Knot at
high tide roosts in
Denmark (max. 78,162),
Schleswig-Holstein
(199,253), Lower Saxony
(24,328) and the
Netherlands (159,560).



The Wadden Sea is visited by two geographically distinct populations of Knots, Greenland and Canadian-breeding *Calidris c. islandica* and Siberian *C. c. canutus* (Meltofte et al. 1994). The first occurs during migration and winter whereas Siberian birds pass en route to their West-African wintering areas. Timing of migration varies considerably. In Denmark, a pronounced peak occurs during spring migration in April-May, whereas in Schleswig-Holstein numbers build up already in March and remain high until departure in May. In the northern Wadden Sea, Knots are less abundant during autumn migration, when most birds concentrate in the Lower Saxony and Dutch part of the Wadden Sea. Wintering numbers are highest in the Netherlands. Roosting Knots have a strong preference for sand flats, often remote and uninhabited islands. As they concentrate at only a few sites, Knots usually congregate in extremely large flocks.

Only five areas support very high numbers (annual mean >10,000). These are situated in Schleswig-Holstein and the Netherlands. In Schleswig-Holstein, Süderoogsand and Trischen are prime Knot roosts. In the Dutch Wadden Sea, Knots concentrate at Griend, Richel and Vliehors-west at Vlieland. Other sites with high numbers are Norderoogsand, SH, Vliehors-oost, NL, and Blauort-sand, SH.

Unlike other species, Knots are extremely dynamic in their use of high tide roosts (e.g. Piersma et al. 1993, van Gils & Piersma 1999) and therefore also notoriously known for difficulties in assessing accurate numbers during the counts. Single flocks may even use up to 800 km² of intertidal mudflats within a short run of tidal cycles (Piersma et al. 1993). Their flocking behaviour and concentration at very few sites makes them highly susceptible to any kind of disturbance. Nearly all birds (99%) are confined to SPA sites. Many roosts are situated in nature reserves or are so remote

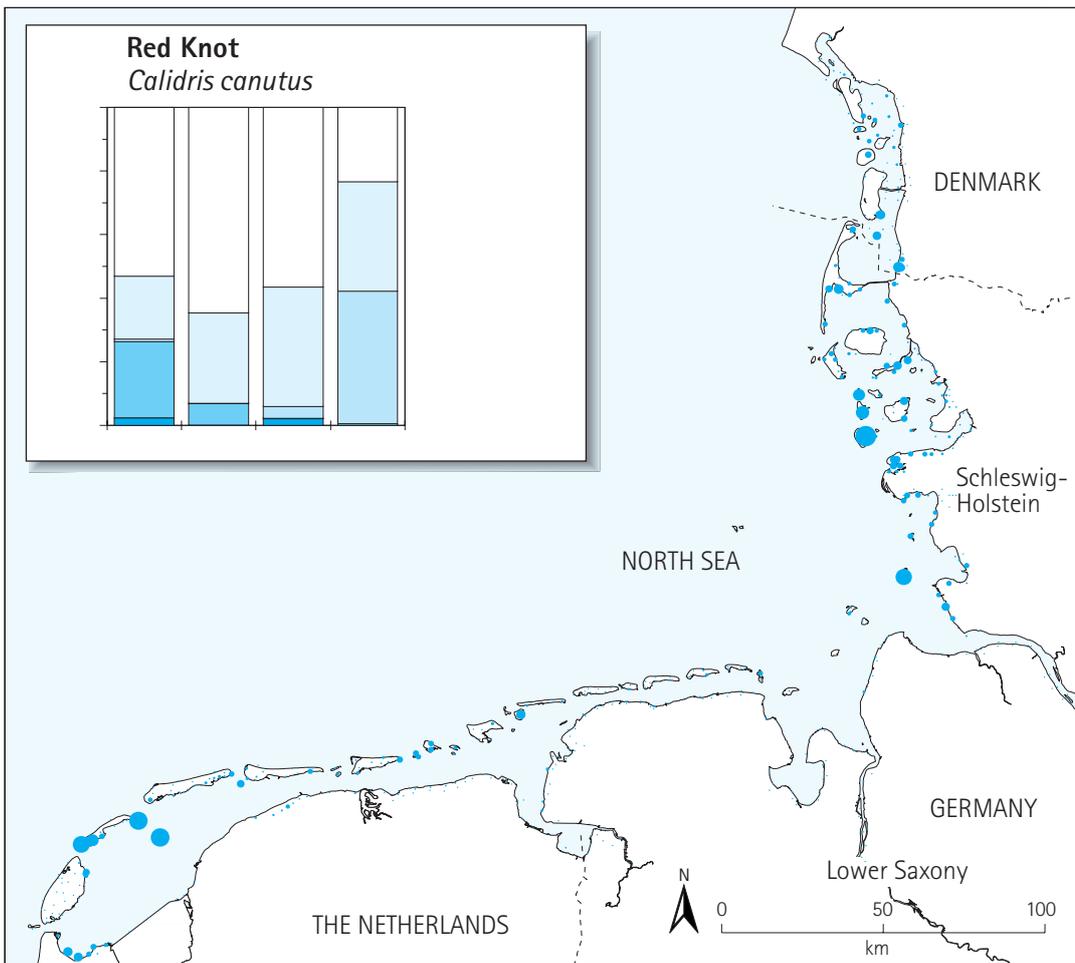


Figure 5.22: Distribution of high tide roosts (map) and habitat distribution of the high tide roosts (inset) of Red Knot in the Wadden Sea.

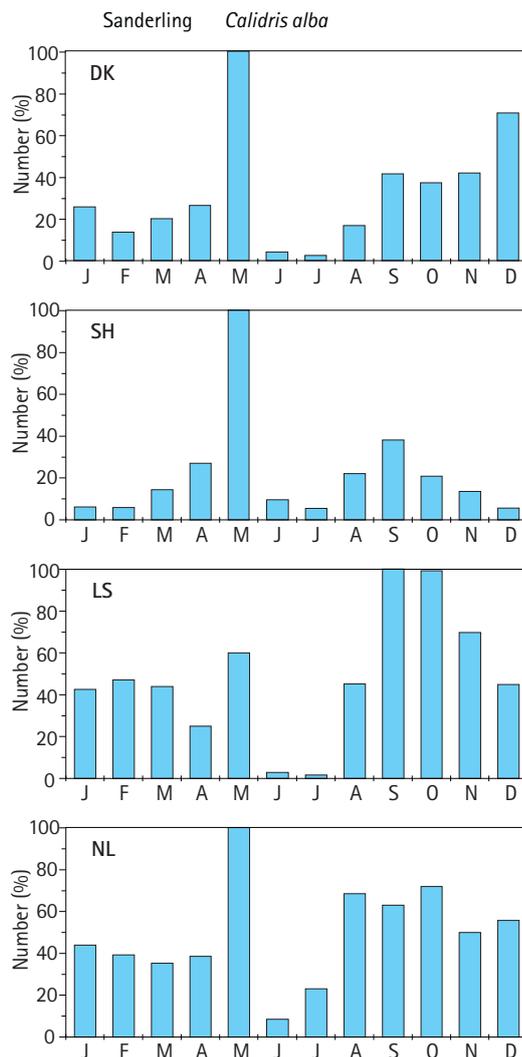
that they are without reach of regular recreational activities. However, aeroplanes and military jet fighters have been reported to disturb large flocks of Red Knots around Vlieland, where they roost close to the military training area of the Vliehors (Koolhaas et al. 1993).

5.2.12 Sanderling

Calidris alba

DK: Sandløber D: Sanderling NL: Drieteenstrandloper

Figure 5.23:
Phenology of Sanderling at
high tide roosts in Denmark
(max. 4,373), Schleswig-
Holstein (15,102), Lower
Saxony (3,329) and the
Netherlands (7,773).



Sanderlings are frequently observed during spring and autumn migration, but winter in much smaller numbers in the Wadden Sea, especially in Lower Saxony and in the Netherlands (Meltofte et al. 1994). In all parts of the Wadden Sea but Lower-Saxony, peak counts are carried out in May. In Lower Saxony, they are most numerous from September to October. Feeding and roosting sites are mainly confined to beaches and sand flats. There are only few sites where Sanderlings occur at the mainland coast. At least in Schleswig-Holstein they roost at the edge of the salt marsh at Dieksanderkoog-Süd (up to 13,000 birds in May – the mean is much lower, only reported in 2001 in that high number, in other years 2,000–4,000 birds) and in the inner part of the Eider estuary (i.e. inland side of the barrage), where up to 1,800 birds were reported feeding on muddy tidal flats during low tide in the brackish zone of the estuary. At the latter site, the high tide roost is not well known, but it seems that the birds are roosting at the edge of the nearest salt marshes within the estuary.

The preference for sandy areas is clearly expressed by the distribution, which is mainly confined to the islands. The only outstanding site for Sanderling is Trischen, SH, (annual mean 1,600) and Dieksanderkoog, SH, in recent years (maximum 13,000, but usually 2,000–4,000). Smaller numbers gather at, e.g., Vliehors-west/Vlieland, NL, St. Peter-Böhl, SH, Westerhever sand, SH, Richel, NL, Blauortsand, SH and Süderoogsand, SH. Nearly all birds (99%) stay within SPA boundaries. Especially mainland sites in Schleswig-Holstein and at North Sea beaches in the Netherlands and Denmark are intensively visited by tourists. It is not known to what extent disturbance occurs but it seems that Sanderling cope rather well with human activities and that food availability is a more important factor influencing the distribution of the species.

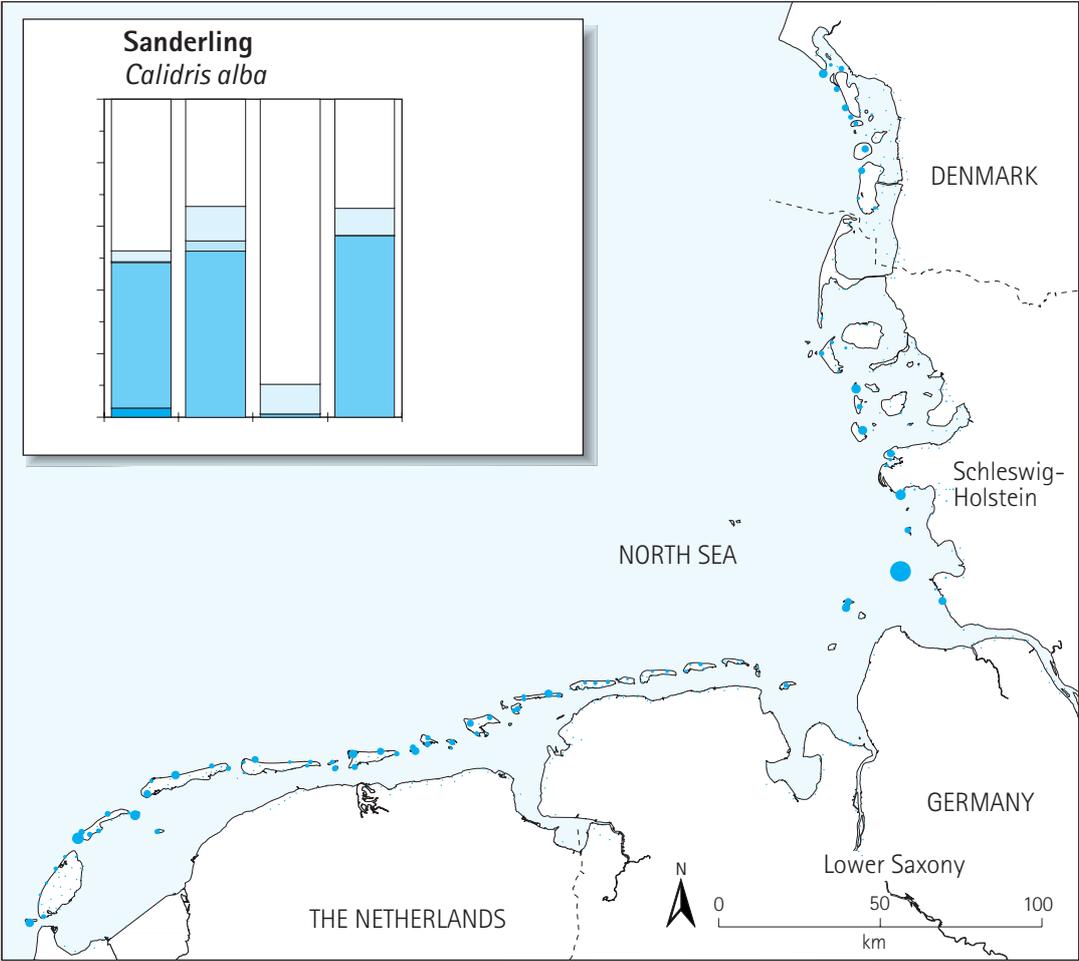


Figure 5.24: Distribution of high tide roosts (map) and habitat distribution of the high tide roosts (inset) of Sanderling in the Wadden Sea.

5.2.13 Curlew Sandpiper

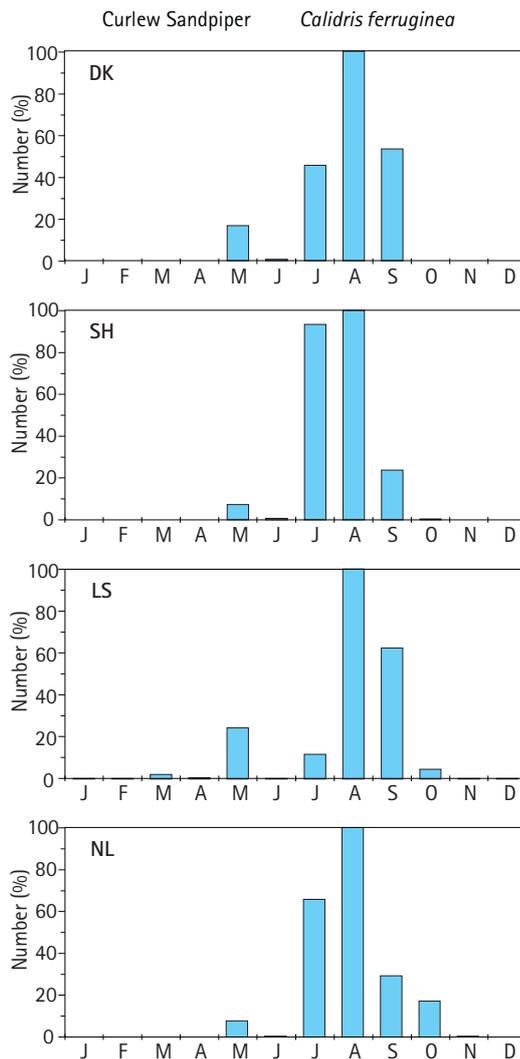
Calidris ferruginea

DK: Krumnæbbet Ryle

D: Sichelstrandläufer

NL: Krombekstrandloper

Figure 5.25:
Phenology of Curlew
Sandpiper at high tide
roosts in Denmark (max.
332), Schleswig-Holstein
(9,777), Lower Saxony
(197) and the Netherlands
(954).



Curlew Sandpipers occur in the Wadden Sea mainly during autumn migration (Meltofte *et al.* 1994). Phenology is highly synchronised with a distinct peak in July-September (maximum in August). Spring migration involves much smaller numbers passing mainly in May (especially at the outer Elbe estuary in Schleswig-Holstein). Roosting sites during high tide are mainly found at salt marshes. In Denmark, Curlew Sandpipers concentrate mainly in inland wetlands like the artificial saltwater lagoon of Margrethe Kog.

There is only one region in the entire Wadden Sea which supports considerable numbers of Curlew Sandpipers, i.e. the mudflats just North of the Elbe in SH. Main high tide roosts here are the salt marshes of Dieksanderkoog-Süd, Kaiser Wilhelm Koog and Neufelder Koog. These sites support on average 230-800 birds annually with peak counts of up to 21,000 birds mainly in these areas. Much smaller numbers are observed at the salt marsh of Dieksanderkoog-Nord, SH, along the Syltdam, SH, and at Bildtpollen, NL. Most birds (94%) stay within boundaries of SPA zones. Concerning the extent of concentration at only a few sites, Curlew Sandpipers are susceptible to potential disturbance, especially as they do not roost at remote islands (like Red Knot) but gather at salt marshes.

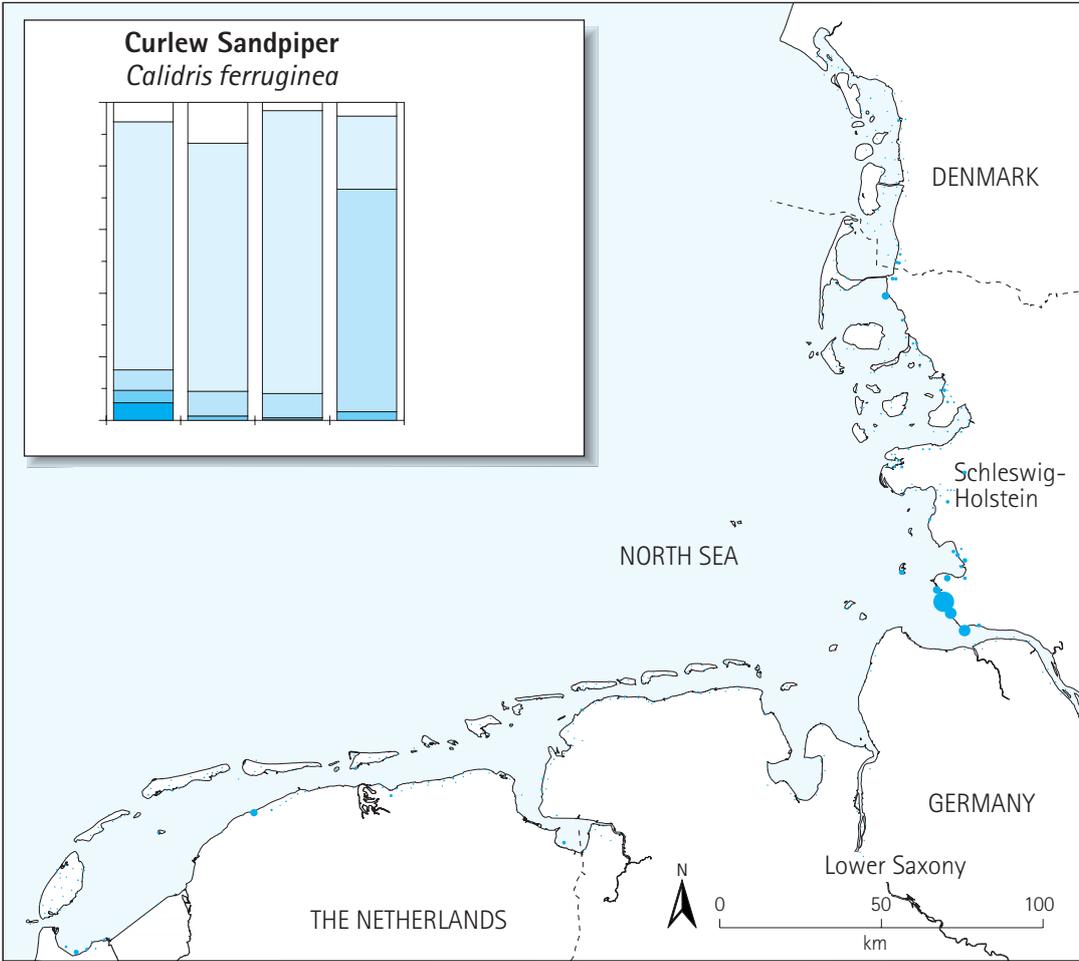


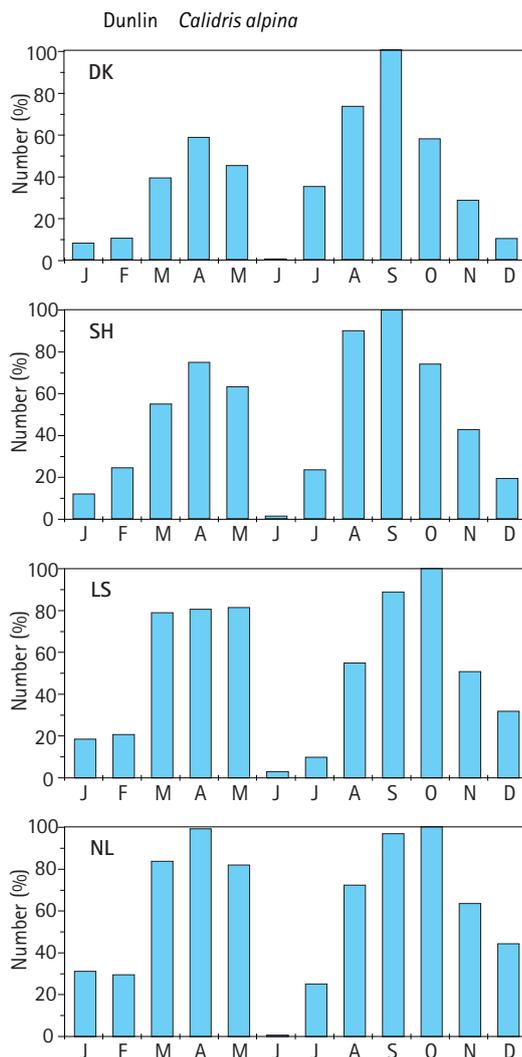
Figure 5.26: Distribution of high tide roosts (map) and habitat distribution of the high tide roosts (inset) of Curlew Sandpiper in the Wadden Sea.

5.2.14 Dunlin

Calidris alpina

DK: Almindelig Ryle D: Alpenstrandläufer NL: Bonte Strandloper

Figure 5.27:
Phenology of Dunlin at
high tide roosts in
Denmark (max. 110,622),
Schleswig-Holstein
(26,388), Lower Saxony
(41,181) and the
Netherlands (33,284).



Dunlin is one of the most abundant species in the Wadden Sea. Besides a small breeding population of *C. a. schinzii* (Rasmussen et al. 2000), large numbers of Eurasian breeding *C. c. alpina* visit the area during migration (Meltofte et al. 1994). During low tide, distribution of Dunlin is especially associated with rather muddy intertidal flats (Ens et al. 1993). Phenology is dominated by huge spring and autumn passage in March-May and August-October, respectively. Autumn numbers tend to be higher than those in spring, but this difference disappears in the western half of the Wadden Sea. Thus, in the Netherlands spring and autumn numbers are equal. High tide roosts are situated on sand flats, as well as salt marshes and in the inland lagoons of Margrethe Kog, DK, Beltringharder Kog, SH, and Meldorfer Kog, SH.

Although Dunlin are widely distributed over the entire area, nearly all birds (98%) gather at SPA sites. Several sites support large roosts (annual mean >20,000). Two of these are within the Margrethe Kog, DK. Equal numbers are observed at the salt marsh of Dieksanderkoog-Süd, SH (with slightly smaller numbers in adjacent sites). Large numbers are also regularly observed between Mandø and Fanø, DK, Scharhörn, LS, Dollard, NL, Bildtpollen, NL, Griend, NL and Richel, NL. No specific threats could be identified.

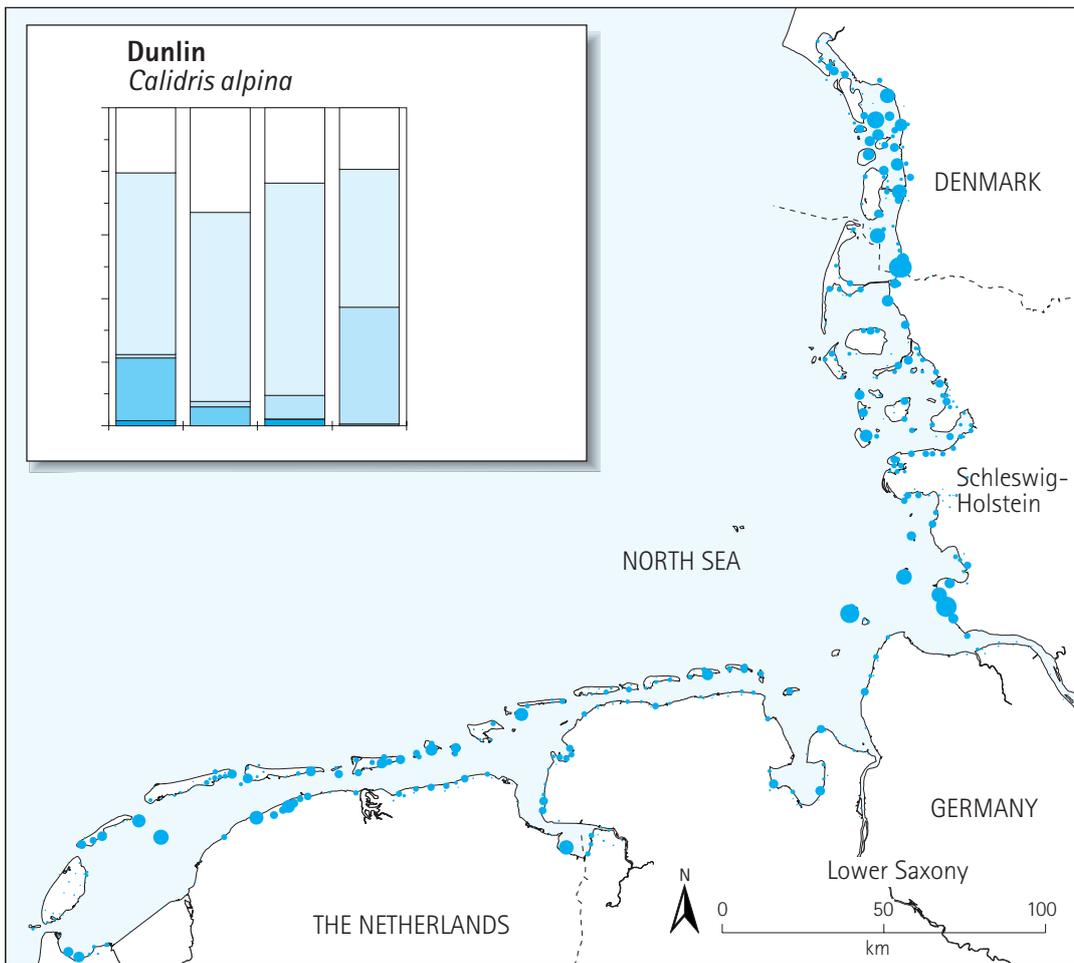
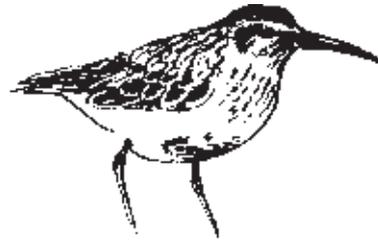


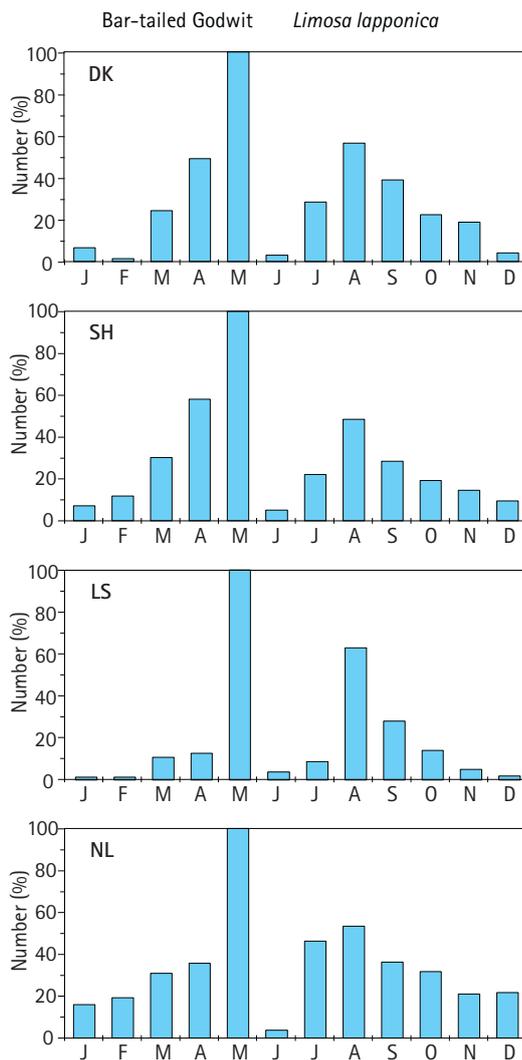
Figure 5.28: Distribution of high tide roosts (map) and habitat distribution of the high tide roosts (inset) of Dunlin in the Wadden Sea.

5.2.15 Bar-tailed Godwit

Limosa lapponica

DK: Lille Kobbersneppe D: Pfuhschnepfe NL: Rosse Grutto

Figure 5.29:
Phenology of Bar-tailed
Godwit at high tide roosts
in Denmark (max. 53,634),
Schleswig-Holstein
(99,020), Lower Saxony
(45,480) and the
Netherlands (130,280).



Bar-tailed Godwits are abundant in the Wadden Sea and occur in large numbers during spring and autumn migration. Similar to Knot, two populations are involved; the Scandinavian population, wintering in the Wadden Sea, and the Siberian population wintering in Africa (Meltofte et al. 1994). In winter, only small numbers remain (Meltofte et al. 1994). Phenology is rather synchronised in the different Wadden Sea regions, with a distinct peak of Siberian birds during spring migration in May. Autumn migration starts in July and proceeds well into autumn. In winter, most Bar-tailed Godwits are observed in the Dutch part of the Wadden Sea. Distribution during low tide is mainly concentrated towards the more sandy sediments (Ens et al. 1993). High tide roosts are mainly situated at salt marshes and sand flats, in the Netherlands, also at beaches. In the Netherlands, Schleswig-Holstein, and especially Denmark, small numbers are observed at inland sites. Here, they feed on insect larvae at improved grasslands in coastal polders during spring migration in May, before departure to the breeding areas (Rasmussen unpubl., van de Kam et al. 1999).

About 93% of all Bar-tailed Godwits concentrate within SPA designated areas. Largest concentrations (annual mean >2,000 birds) are mainly situated in the western Wadden Sea, around the islands Griend, NL, Richel and Vlieland, NL. Furthermore, Memmert/Lütje Hörn, LS and in Schleswig-Holstein, Japsand, Königshafen, Hörnum Nehrung, Dieksanderkoog-Süd, and Neufelder Koog support large roosts of Bar-tailed Godwits. Nearly all these sites represent rather remote areas with little or no regular disturbance. However, the roosting sites at Vlieland are situated in the military training area of the Vliehors (cf. Red Knot).

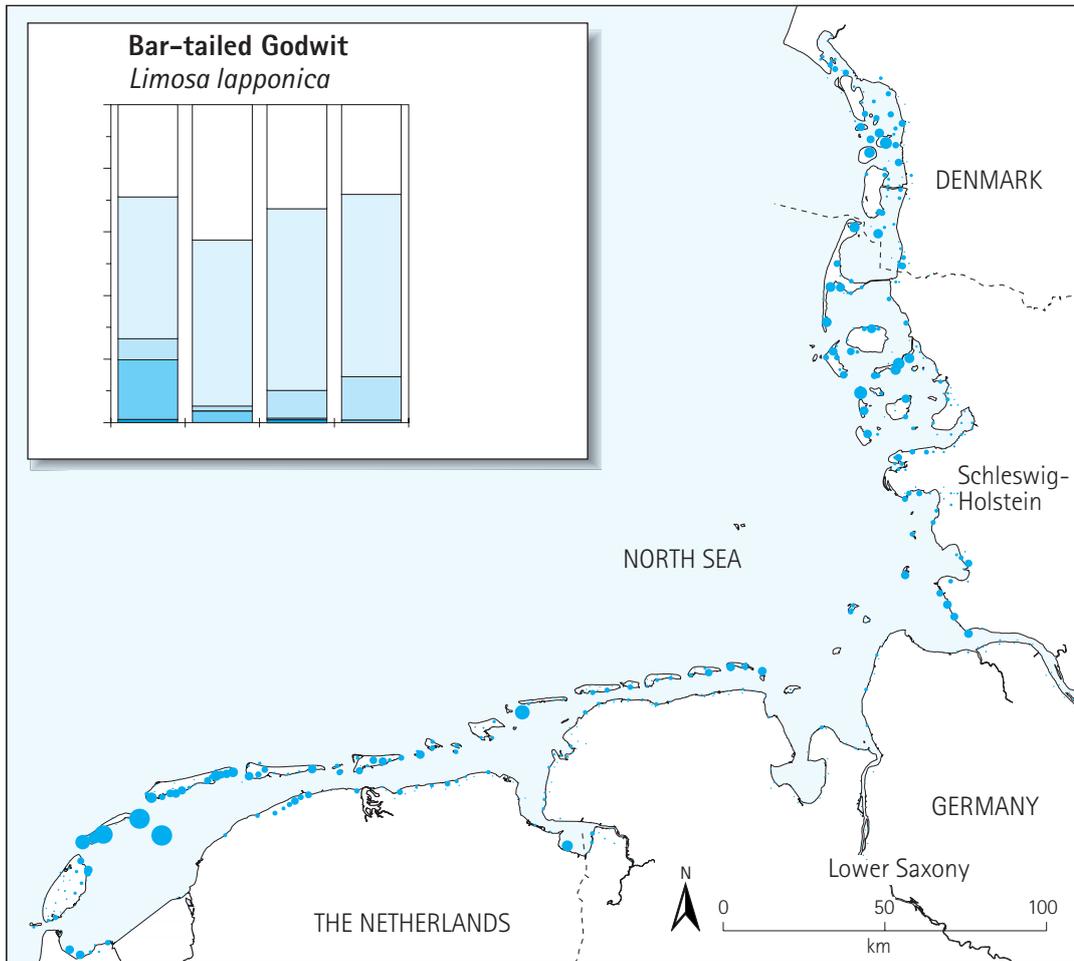
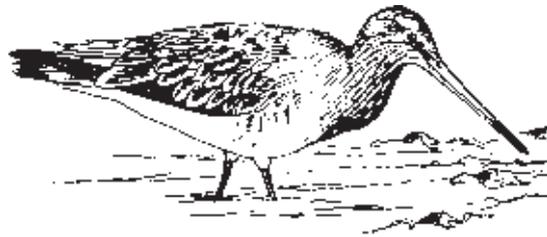


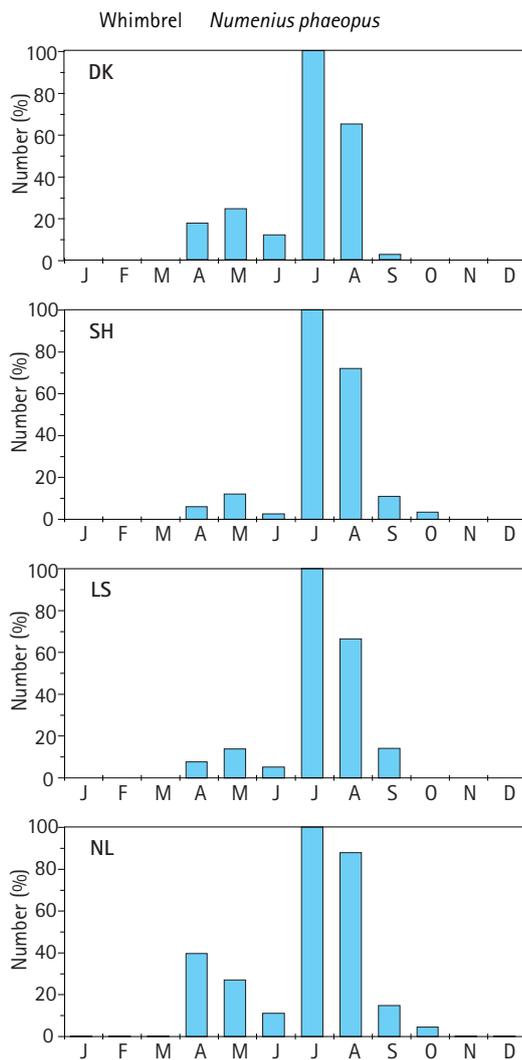
Figure 5.30: Distribution of high tide roosts (map) and habitat distribution of the high tide roosts (inset) of Bar-tailed Godwit in the Wadden Sea.

5.2.16 Whimbrel

Numenius phaeopus

DK: Lille Regnspove D: Regenbrachvogel NL: Regenwulp

Figure 5.31:
Phenology of Whimbrel at
high tide roosts in
Denmark (max. 559),
Schleswig-Holstein (670),
Lower Saxony (1,148) and
the Netherlands (997).



Whimbrel pass the Wadden Sea on migration between their West-African wintering areas and (sub)arctic breeding sites (Meltofte et al. 1994). However, the species is less common on intertidal mudflats and mainly feeds in inland areas where most of them are not included in the counts. Many of these birds use the Wadden Sea to roost. Important roosts are, e.g., found along the Frisian Wadden Sea coast (M. Engelmoer) and in the Ems Estuary (Gerdes 2000).

Numbers recorded during surveys in the Wadden Sea are rather small, and often refer to birds feeding at rocky habitats like breakwaters in harbours and outer, seaward parts of dikes. Also this species, when feeding in the intertidal area, does not really gather in flocks during high tide. Phenology is similar in all parts of the Wadden Sea, with usually highest numbers in July and August. Spring migration is less pronounced, and is observed mainly by the end of April and in May. During high tide, most Whimbrels have been observed at salt marshes and inland sites. The common habit of feeding along dikes and breakwaters is expressed by the observations in the Netherlands.

About 93% of observed Whimbrel stay within SPA areas. However, this figure is low since more birds stay at inland sites which are not included in the counts (and which are not designated as SPAs). The species occurs in all parts of the Wadden Sea, with no sites holding significant numbers. Whimbrel frequent often mainland coasts (especially the Netherlands and Lower Saxony) and islands with large polders with improved grassland. On Sylt, SH, up to 500-1,000 birds occur in June-July, mainly feeding in the dunes on berries of crow-berries *Empetrum nigrum* (Birlenbach 2000).

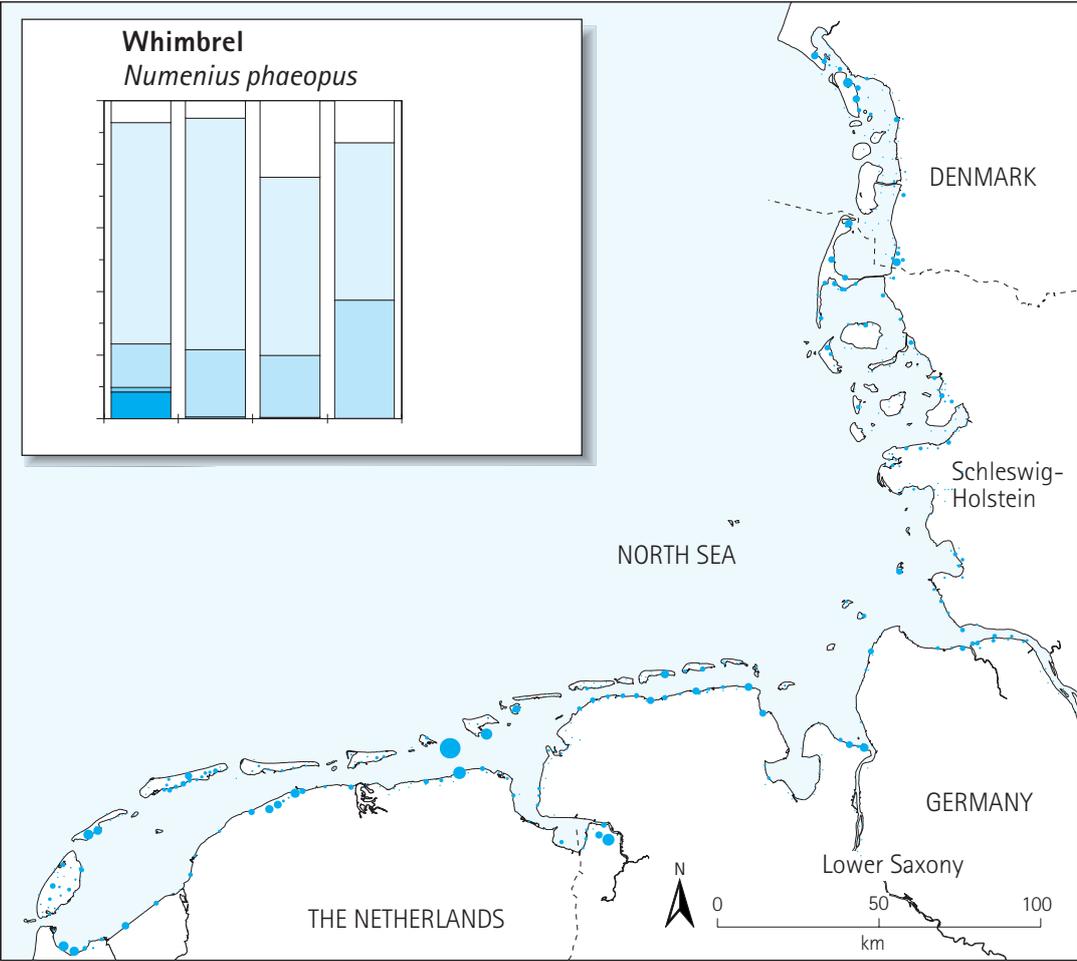


Figure 5.32: Distribution of high tide roosts (map) and habitat distribution of the high tide roosts (inset) of Whimbrel in the Wadden Sea.

5.2.17 Curlew

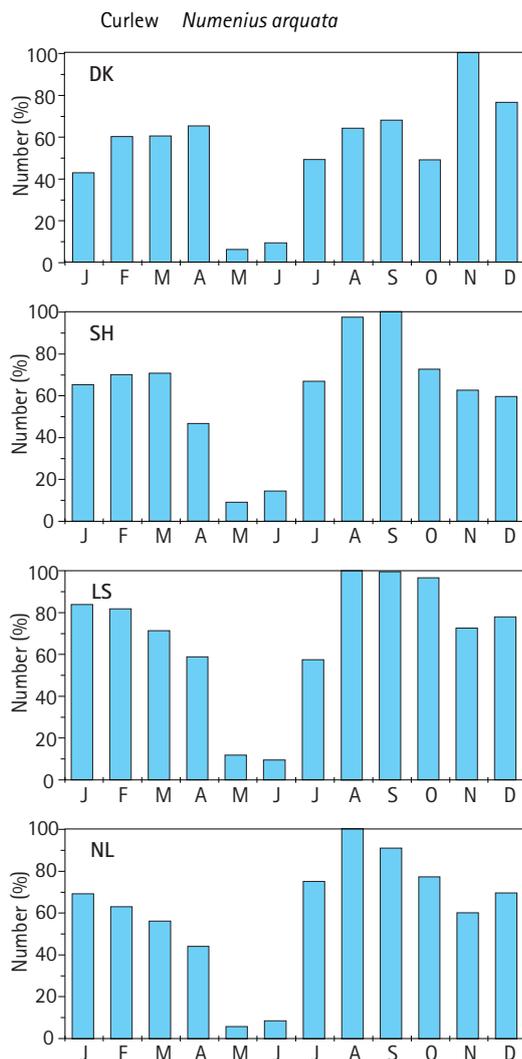
Numenius arquata

DK: Stor Regnspeve

D: Großer Brachvogel

NL: Wulp

Figure 5.33:
Phenology of Curlew at
high tide roosts in
Denmark (max. 20,860),
Schleswig-Holstein
(51,496), Lower Saxony
(79,447) and the
Netherlands (133,212).



Curlew is one of the most common waterbirds observed in the Wadden Sea. Besides a small breeding population in the Netherlands, Lower Saxony and Denmark, large numbers are present in the area during migration and for moulting (Meltofte et al. 1994). The birds frequent various types of mudflats, but tend to prefer lower muddy parts and mussel beds (Ens et al. 1993). Curlews are observed in large numbers throughout the year (with slightly larger numbers in autumn), except May and June, when birds have departed for the (northern) breeding areas. Peak numbers usually stay during moult in August–September, in Denmark, as late as November and December. Roosts are mainly situated at salt marshes. In Denmark, large numbers concentrate at inland sites in the artificial saltwater lagoon of Margrethe Kog. The numbers found in inland agricultural areas are severely underestimated since many Curlew visit improved grassland areas at further distance from the dike, and therefore remain out of sight of the observers (Zwarts 1996, Gloe 1998). Often these birds use the Wadden Sea to roost during night.

Most Curlew stay within SPA boundaries (94% of all birds observed), although this figure is over-estimated due to the large numbers at inland sites, which are not covered during the counts (but, however, do roost in the Wadden Sea, see above). Sites with highest numbers are situated in the Netherlands, Lower Saxony and the southern part of Schleswig-Holstein. Few sites hold annual means > 3,000 individuals: Bildtpollen, NL, Trischen, SH, Richel, NL, Spiekeroog Ost, LS, and Griend, NL. In Schleswig-Holstein, high numbers also occur at the salt marsh of Dieksanderkoog-Süd. Large roosts are situated at islands as well as mainland coasts. Curlew is known to be highly susceptible to disturbance and is one of the species with the largest flight distance (see chapter 3). Large numbers usually concentrate at roosts with little or no public access (all sites mentioned above). From the roost at the eastern end of Ameland, NL, it is known that birds switch to the Frisian mainland coast during the summer tourist

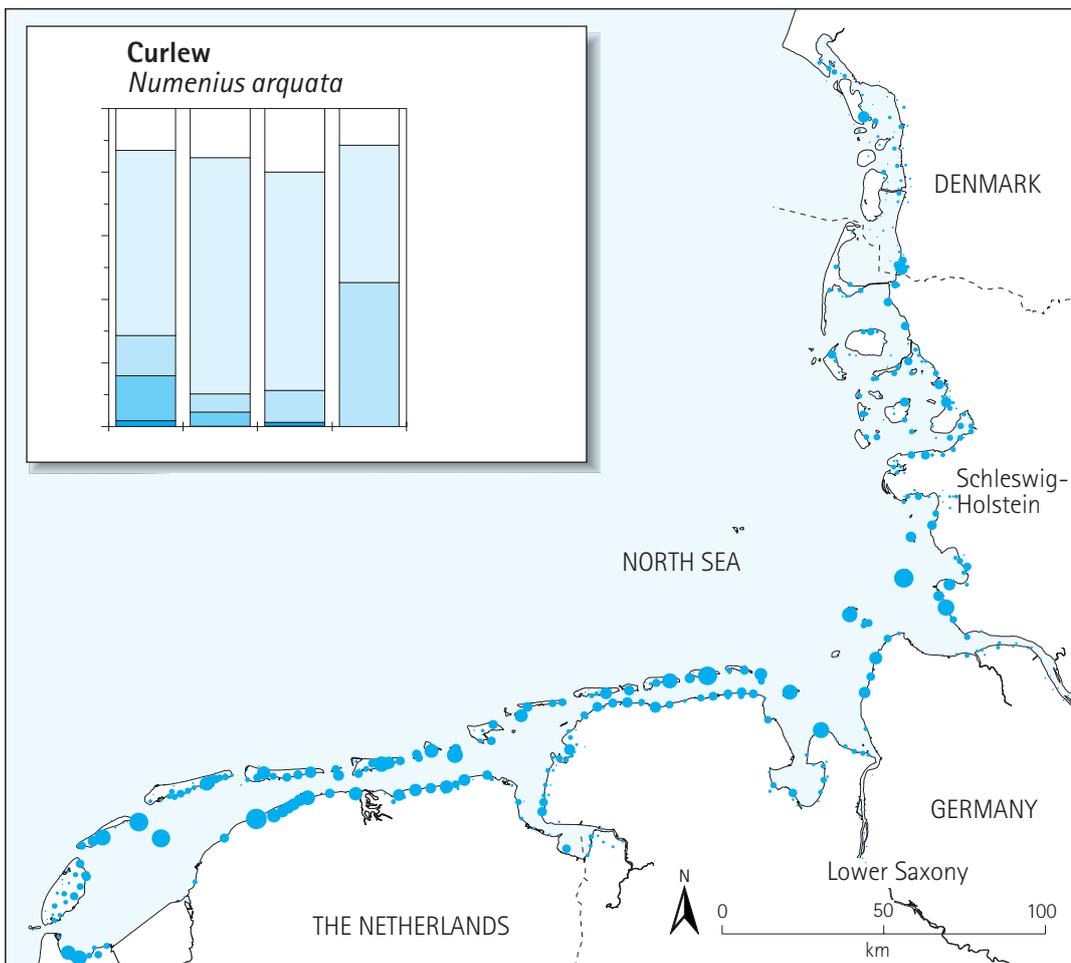
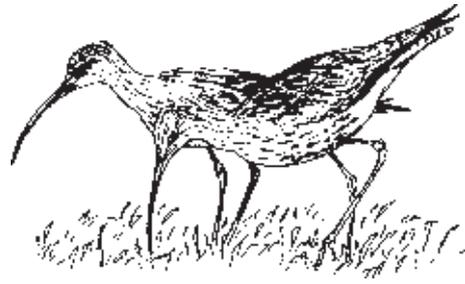


Figure 5.34: Distribution of high tide roosts (map) and habitat distribution of the high tide roosts (inset) of Curlew in the Wadden Sea.

season (Kersten *et al.* 1997). A similar pattern was found in Lower Saxony, at Wangerooge (Südbeck 1999; see also chapter 6.3). In Denmark, Curlews are more concentrated at a few sites without hunting or other human disturbance in late summer and autumn, but are more numerous on the mainland in spring. This is thought to be an effect of

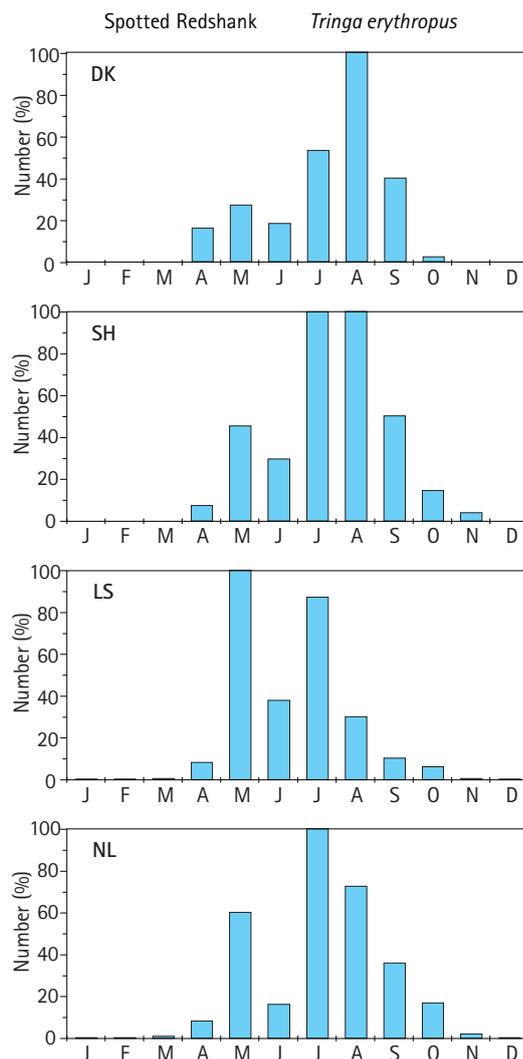
disturbance by hunting (Rasmussen 2001). The Curlew was hunted until 1994. Since then numbers have increased and is now as common as in other parts of the Wadden Sea. In winter 4-5 times as many Curlews are now present compared to the situation before 1994 (Rasmussen 2001).

5.2.18 Spotted Redshank

Tringa erythropus

DK: Sortklire D: Dunkler Wasserläufer NL: Zwarte Ruiter

Figure 5.35:
Phenology of Spotted Redshank at high tide roosts in Denmark (max. 5,688), Schleswig-Holstein (10,172), Lower Saxony (3,087) and the Netherlands (6,024).



Spotted Redshank is a scarce migratory species in the Wadden Sea and only very few are observed in winter (Meltofte et al. 1994). Highest numbers are observed during spring migration in May and autumn migration from June onwards (starting with moulting birds in June and July, Meltofte et al. 1994). However, timing and peak numbers slightly differ. Both the Netherlands (although relatively small numbers) and especially Lower Saxony have a more pronounced peak in May, whereas Denmark and Schleswig-Holstein support highest numbers in July-September. Also, the Netherlands have largest numbers in July and August. Occurrence during high tide is mainly confined to salt marshes and inland sites (mainly wetlands). In Denmark, nearly all Spotted Redshanks concentrate at Margrethe Kog, an inland site.

More than 97% of all observed Spotted Redshanks roost in SPA designated areas. However, most roosts hold only small numbers. Especially brackish mudflats are favoured feeding sites. Three sites stand out in Spotted Redshank abundance: Dollard, NL, Meldorferkoog-Nord, SH, and Neufelder Koog-West, SH. These sites support annual means of 475-600 individuals. Much smaller numbers are found at several sites in Schleswig-Holstein, the German part of the Dollard and along the mainland coast in the Netherlands. In Denmark, the species is scarce and only occurs in high numbers in the Margrethe Kog. Apart from the Dutch Dollard, where human disturbance is virtually absent, all important sites have occasional recreational activities. The site at Meldorferkoog-Nord is close to the military training site in the southern part of the Meldolfer Bucht.

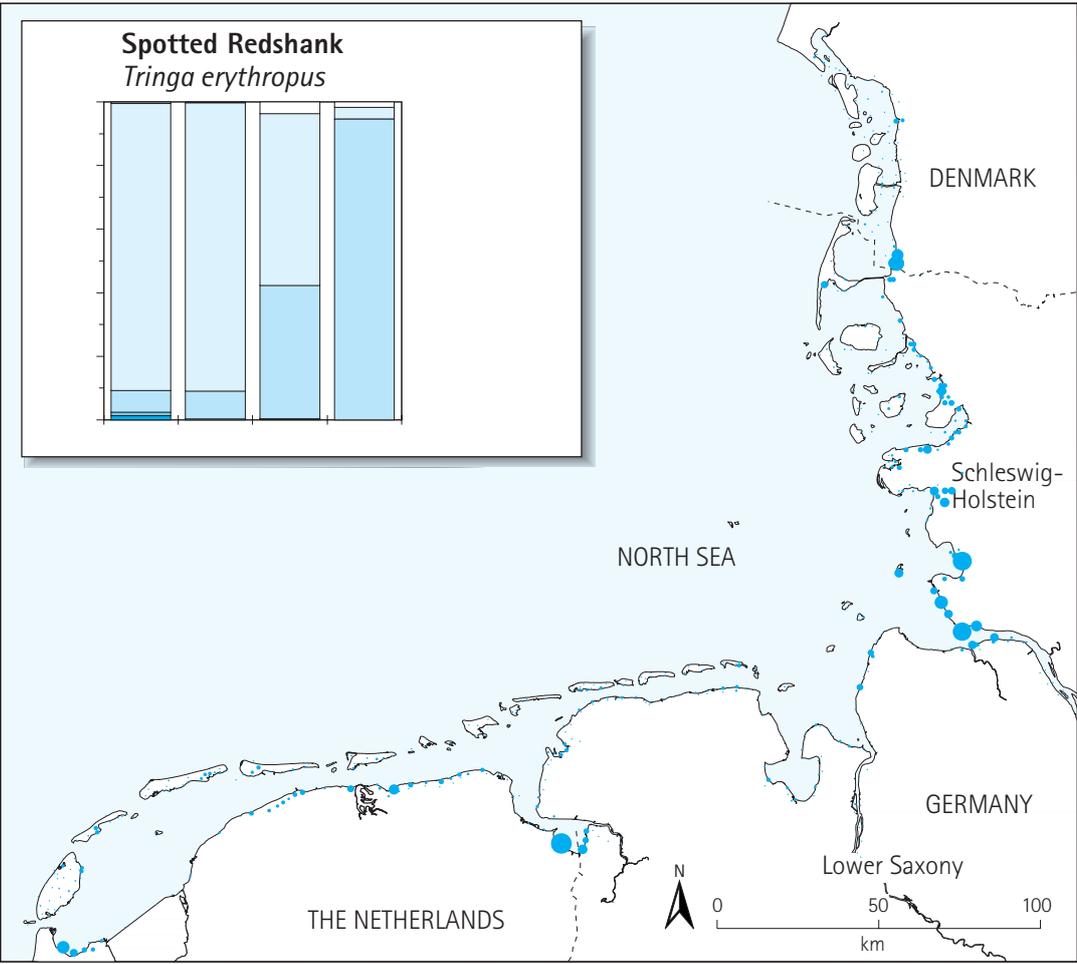


Figure 5.36: Distribution of high tide roosts (map) and habitat distribution of the high tide roosts (inset) of Spotted Redshank in the Wadden Sea.

5.2.19 Redshank

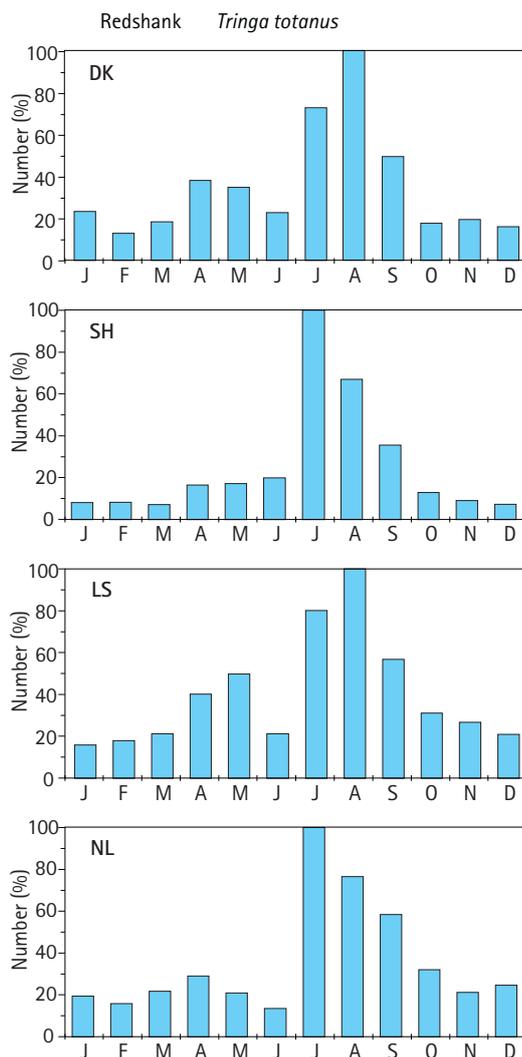
Tringa totanus

DK: Rødben

D: Rotschenkel

NL: Tureluur

Figure 5.37:
Phenology of Redshank at
high tide roosts in
Denmark (max. 7,593),
Schleswig-Holstein
(24,198), Lower Saxony
(16,360) and the
Netherlands (37,395).



Three different geographically distinct populations of Redshank occur in the Wadden Sea (Meltofte et al. 1994). Largest numbers belong to *totanus* and *robusta* Redshanks, breeding on the European continent and Iceland. In winter, also small numbers of British breeding *britannica* are supposed to winter in the Wadden Sea. Phenology is rather uniform in all countries, with high numbers in July-September (peak July or August). Pronounced spring migration is not visible, except in Denmark and Lower Saxony, where a small peak occurs in March-April. During low tide, Redshank are especially associated with lower parts of the intertidal area, either sandy or muddy sediments (Ens et al. 1993). Besides, they feed at mussel beds. Typical roosts are mainly situated in salt marshes. Smaller numbers also occur inland. In Schleswig-Holstein and Denmark, some birds also frequent sand flats.

About 94% of all Redshanks were recorded at SPA sites. The species is especially numerous in the Netherlands and Lower Saxony. Of the 13 sites with highest numbers (holding on average >400 birds/month), 10 are situated in the Dutch part of the Wadden Sea. High numbers especially occur at Oost- and West-Holwerd, Balgzand, Posthuiswad (Vlieland), 2e Duintjes, Boschplaat (Terschelling), De Groede, Boschplaat (Terschelling), Noordpolder-West, Polder West at Ameland and Dollard. Outside the Dutch part of the Wadden Sea, sites with equal high numbers are only the salt marsh of Neufelder Koog-West, SH, the salt marshes between Dornumersiel and Neuharlingsiel, LS, and between Norddeich and Neßmersiel, LS. Among these are a number of sites (4 out of 13) which have regular recreational activities. The site in Polder West at Ameland is situated in an agricultural area with improved grassland.

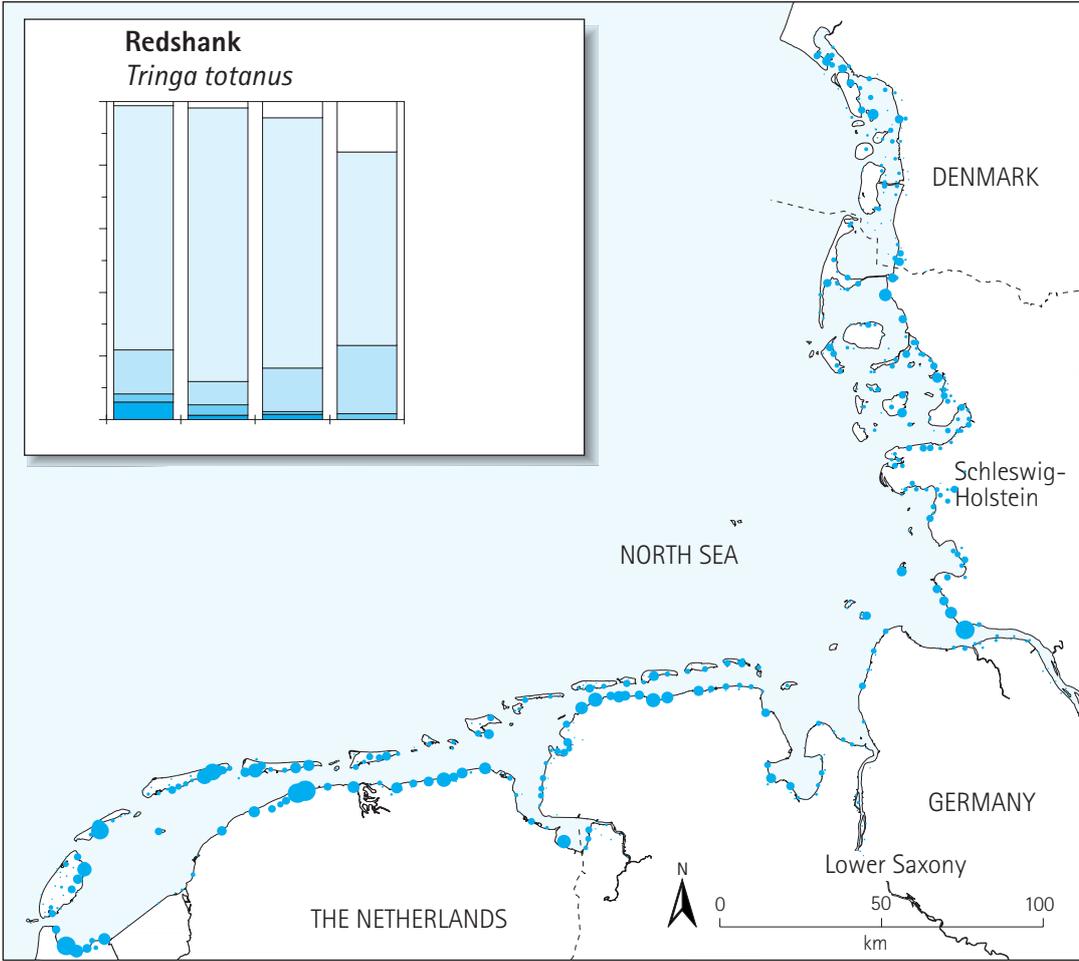
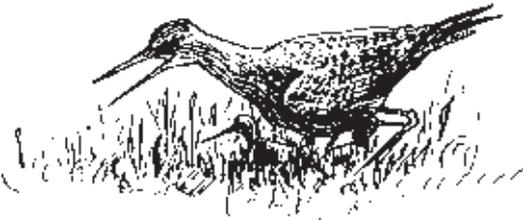


Figure 5.38: Distribution of high tide roosts (map) and habitat distribution of the high tide roosts (inset) of Redshank in the Wadden Sea.

5.2.20 Greenshank

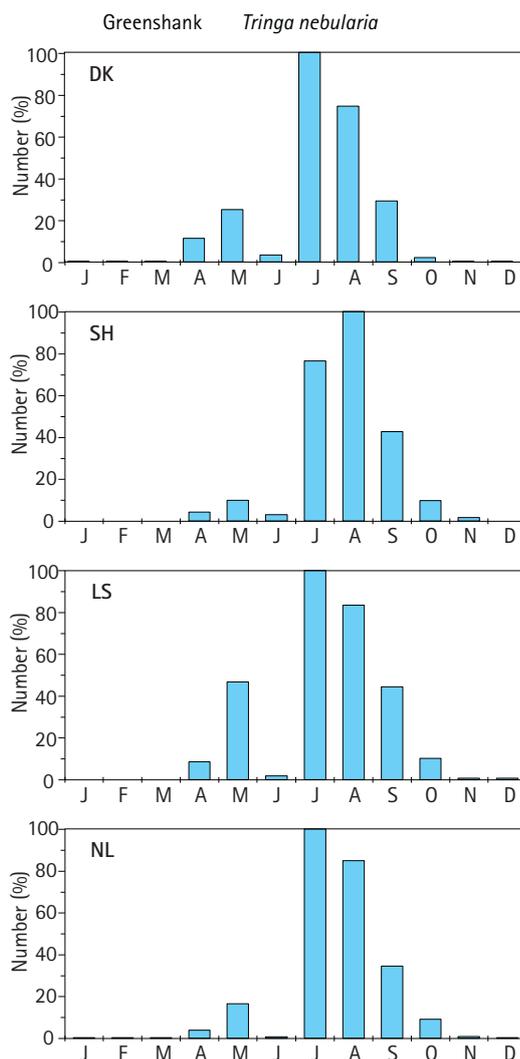
Tringa nebularia

DK: Hvidklire

D: Grünschenkel

NL: Groenpootruiter

Figure 5.39:
Phenology of Greenshank
at high tide roosts in
Denmark (max. 6,023),
Schleswig-Holstein
(5,214), Lower Saxony
(4,444) and the
Netherlands (9,777).



Greenshanks are numerous and widespread during spring and autumn migration (Melfoite et al.1994). Autumn migration by far involves highest numbers and proceeds from July to September, with peak numbers already in July (Schleswig-Holstein in August). Spring migration is less pronounced and is observed in April and May. Only in Lower Saxony, a distinct peak occurs in May. Habits concerning roosting sites are quite similar to Redshank, with largest numbers found at salt marshes. Smaller but significant numbers (especially in Denmark) roost at sand flats and inland sites.

Greenshank are observed in all parts of the Wadden Sea, although this species never concentrates as much as Redshank. About 95% are recorded within boundaries of SPA sites. The most important roosts are situated at some Dutch islands, Weser and Elbe estuaries (both LS and SH), and locally in the Danish Wadden Sea. Among the best sites are De Groede, Boschplaat (Terschelling), NL, nieuwe pier-4e slenk (two sites) at Oosterkwelder (Schiermonnikoog), NL, De Schorren (Texel), NL, salt marsh between Bremerhaven-Cuxhaven, LS, Balgzand, NL, and Margrethe Kog, DK,. All these sites have no significant anthropogenic activities and are situated (except for the salt marsh between Bremerhaven-Cuxhaven) in nature reserves.

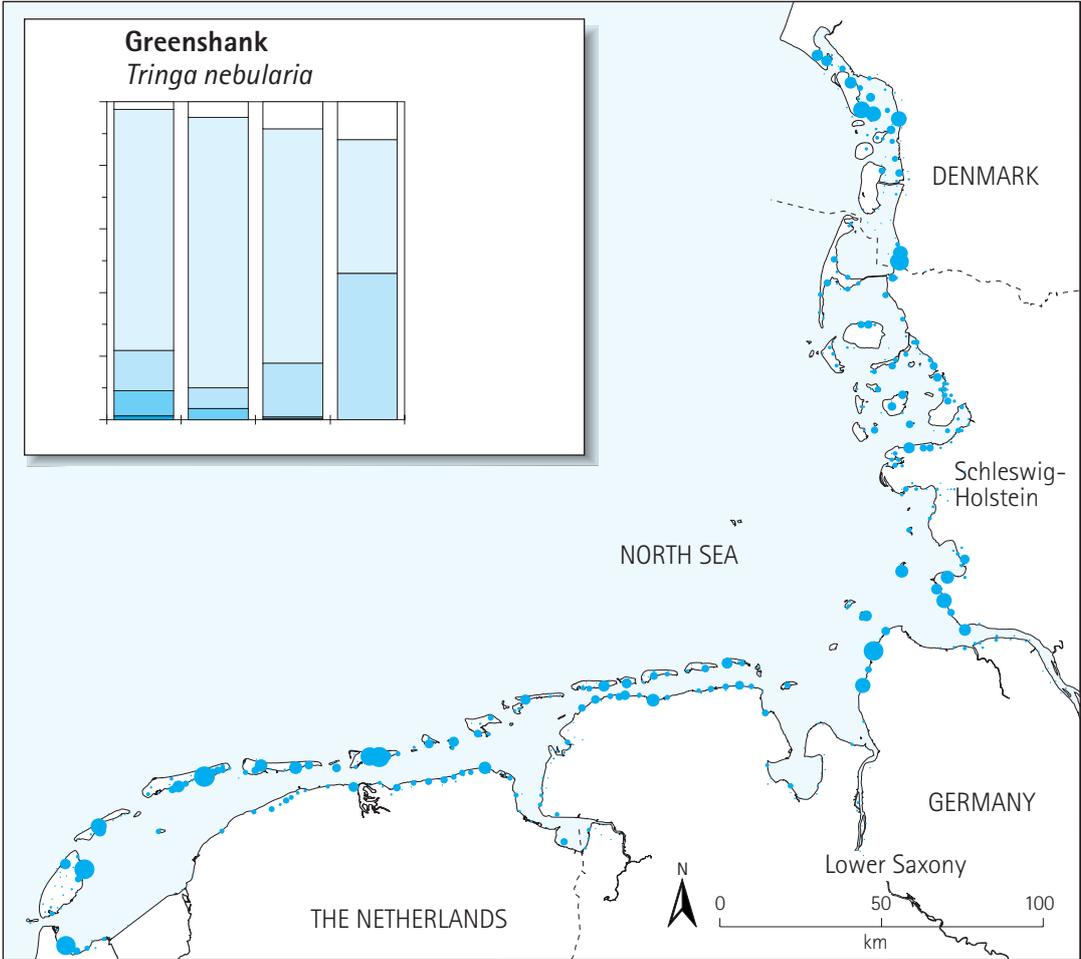


Figure 5.40: Distribution of high tide roosts (map) and habitat distribution of the high tide roosts (inset) of Greenshank in the Wadden Sea.

5.2.21 Turnstone

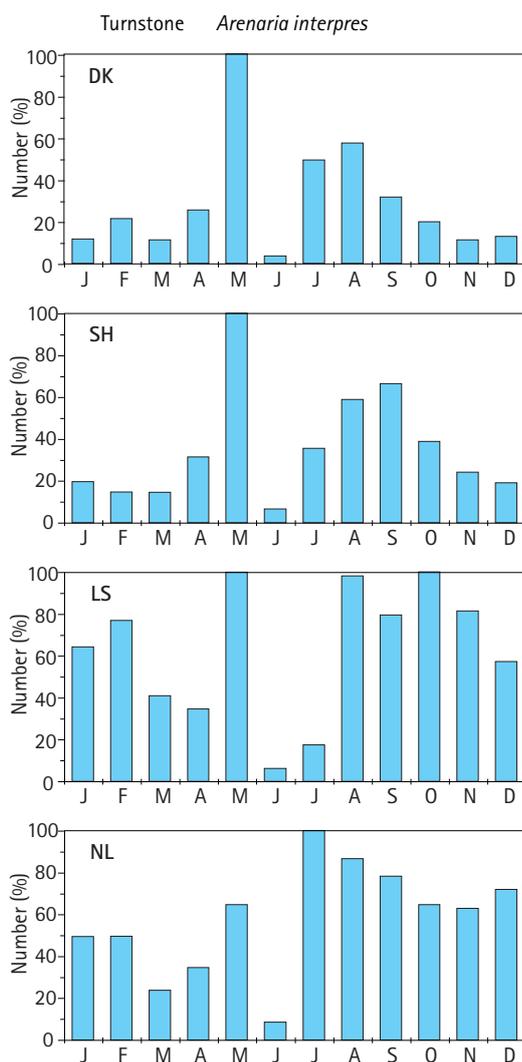
Arenaria interpres

DK: Stenvender

D: Steinwalzer

NL: Steenloper

Figure 5.41:
Phenology of Turnstone at
high tide roosts in
Denmark (max. 2,555),
Schleswig-Holstein
(2,132), Lower Saxony
(1,026) and the
Netherlands (3,378).



Turnstone is an accidental breeding bird in the Wadden Sea. Occasional breeding in Schleswig-Holstein and Denmark represents the southernmost edge of the breeding range of this mainly arctic species (Rasmussen et al. 2000). During migration and winter Greenlandic/Canadian as well as Scandinavian/Russian populations visit the Wadden Sea (Meltofte et al. 1994). In most areas, strong passage is noted in May. However, in the Netherlands, highest numbers are recorded in July. Both the Netherlands and Lower Saxony have high numbers in autumn and winter as well. In Schleswig-Holstein and Denmark, autumn migration is less pronounced and wintering numbers are relatively low. In Denmark, the species has become a more numerous winter visitor in the 1990s. In comparison to other waders, Turnstones prefer quite different habitats for roosting. Many birds frequent artificial "rocky" coasts as breakwaters in harbours and dikes, others beaches and sand flats. Salt marshes are less favoured. Small numbers also visit inland sites, especially in the Netherlands.

Since Turnstone prefers also artificial habitats, the proportion of birds found at SPA sites is less (87%) compared to other waders. Small numbers occur scattered throughout the entire Wadden Sea. Few areas hold annual means of more than 100 individuals. These are situated at the beaches of Skallingen and Langli (three sites) in the northernmost part of the Danish Wadden Sea, at Den Helder, NL (two sites), Trischen, SH, and Harlingen, NL. Most of these sites (except Trischen and Langli) are situated in anthropogenic environments (i.e. harbours) with frequent human disturbance. Among waders, Turnstone is one of the least susceptible species to disturbance and well-adapted to stay in human environment (Spaans et al. 1996).

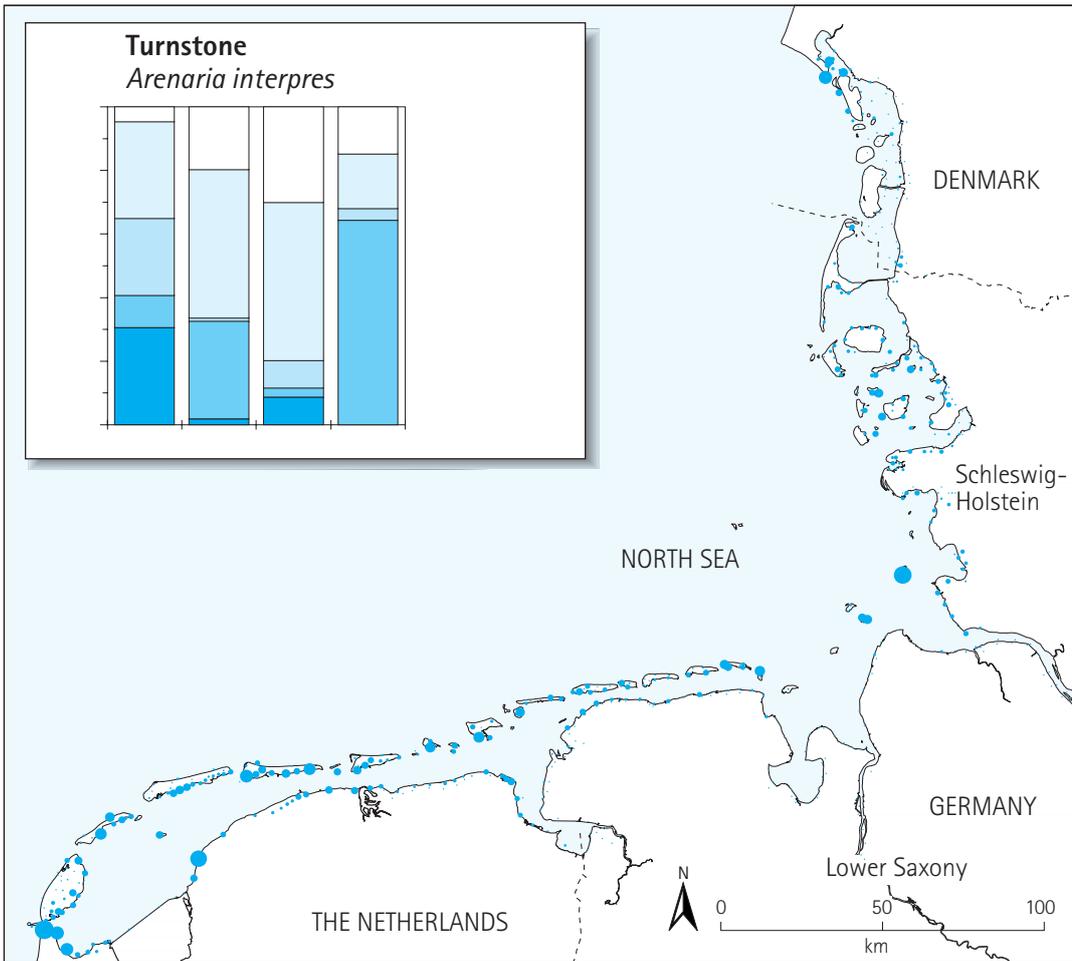
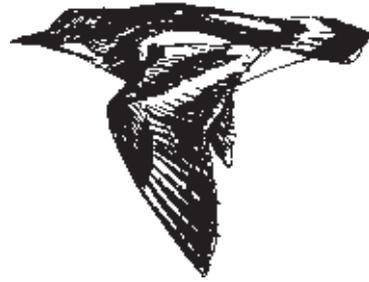


Figure 5.42: Distribution of high tide roosts (map) and habitat distribution of the high tide roosts (inset) of Turnstone in the Wadden Sea.

5.2.22 Black-headed Gull

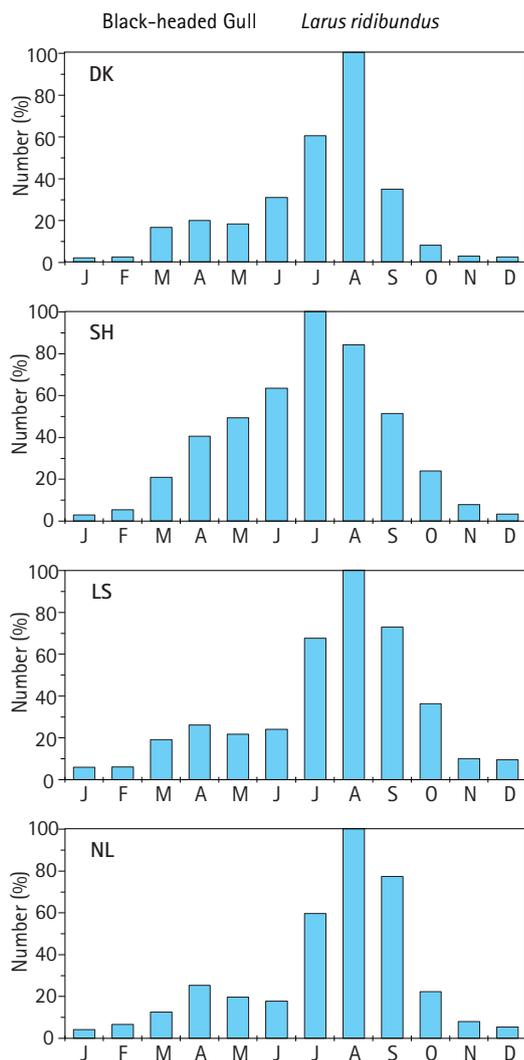
Larus ridibundus

DK: Hættemåge

D: Lachmöwe

NL: Kokmeeuw

Figure 5.43:
Phenology of Black-headed Gull at high tide roosts in Denmark (max. 70,639), Schleswig-Holstein (86,325), Lower Saxony (127,083) and the Netherlands (221,364).



Black-headed Gull is a numerous breeding bird with largest breeding colonies west of the Elbe estuary (Rasmussen et al. 2000). In addition, it has an abundant occurrence outside the breeding season, involving both local breeding birds and northern breeders (Meltotte et al. 1994). Although feeding extensively at the intertidal mudflats, not all birds gather at high tide roosts as some also go offshore for feeding, or frequent inland pastures and arable fields. Often these birds roost in the Wadden Sea during night. Peak numbers in the Wadden Sea are usually present from July-September. Larger numbers are also observed during March-June, mainly consisting of local breeding birds. During winter, only small numbers are observed. High tide roosts are mainly found at salt marshes, but frequently also sand flats, beaches and inland sites are used. The latter are probably underestimated as not all birds at such sites are covered well in the counts.

Black-headed Gulls are widespread in all parts of the Wadden Sea and about 92% stay within SPA designated territory. By far the largest concentrations are found at Griend, NL, and Trischen, SH (annual mean 5,400 and 4,800 respectively). Both sites support large breeding colonies (Rasmussen et al. 2000). Apart from these strongholds, largest numbers are dispersed over the Dutch and Lower Saxony parts of the Wadden Sea. Although the larger sites are often remote and have limited numbers of visitors, Black-headed Gull are generally far less susceptible to anthropogenic disturbance compared to other species (Smit & Visser 1993, Spaans et al. 1996). Potential conflicts mainly occur during the breeding season when most birds attend their breeding colonies.

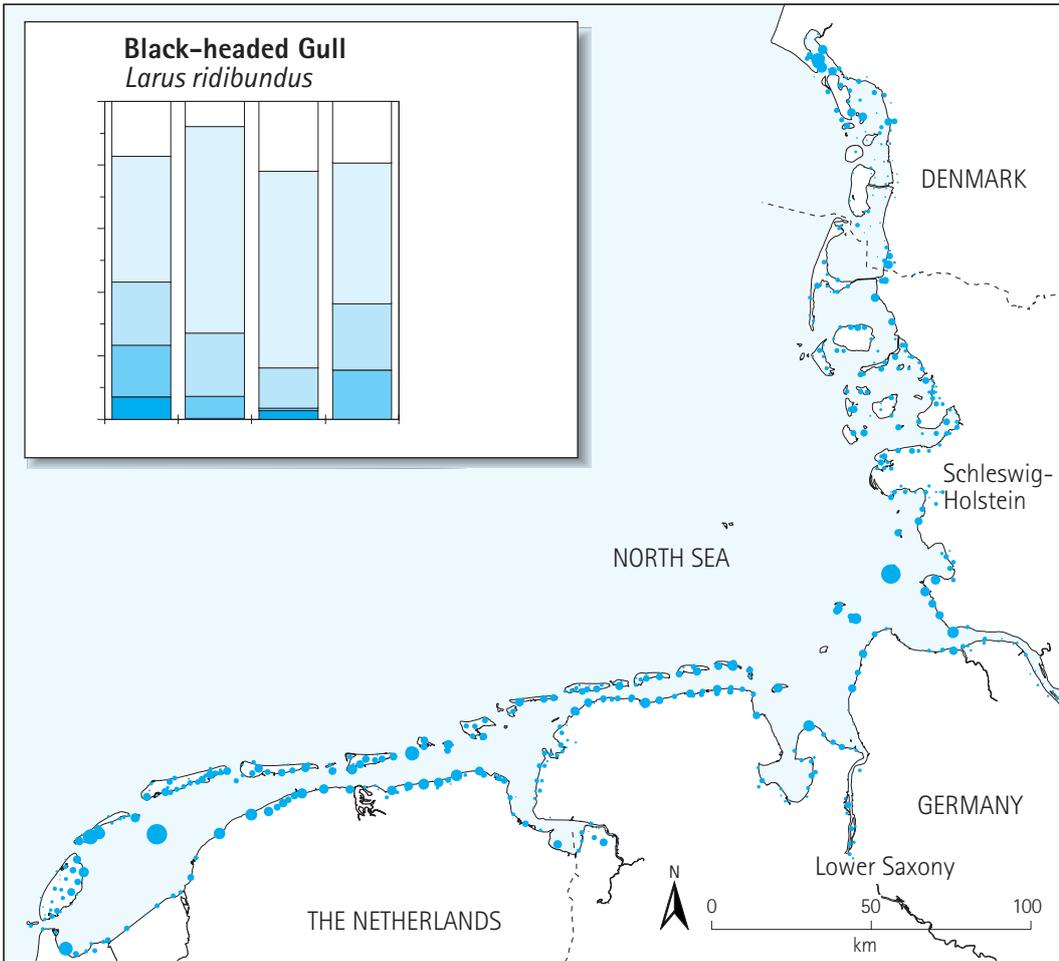
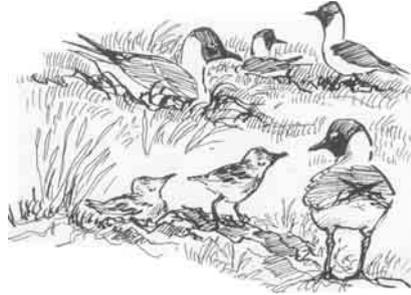


Figure 5.44: Distribution of high tide roosts (map) and habitat distribution of the high tide roosts (inset) of Black-headed Gull in the Wadden Sea.

5.2.23 Common Gull

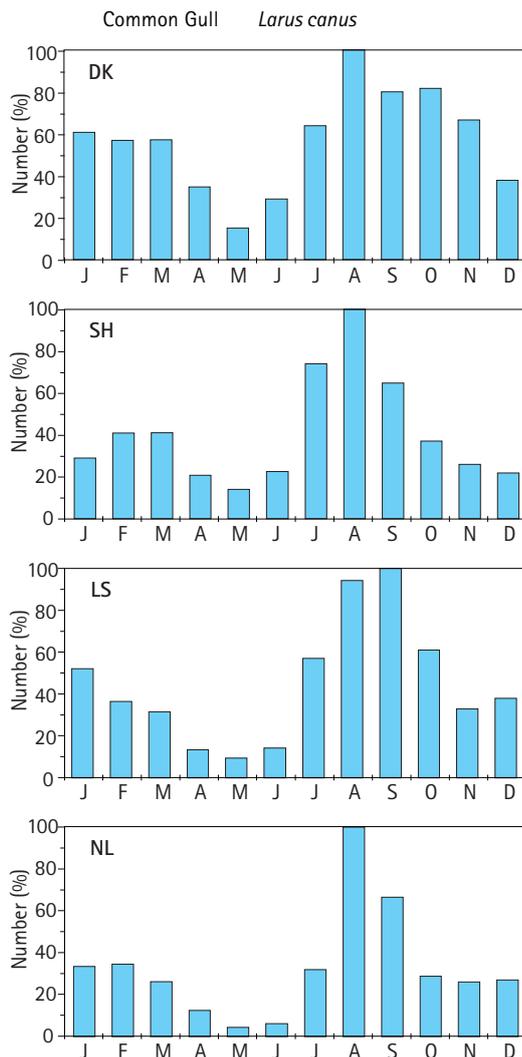
Larus canus

DK: Stormmåge

D: Sturmmöwe

NL: Stormmeeuw

Figure 5.45:
Phenology of Common Gull
at high tide roosts in
Denmark (max. 41,750),
Schleswig-Holstein
(32,181), Lower Saxony
(40,257) and the
Netherlands (113,833).



Common Gull is less common as the Black-headed Gull, but it breeds in all parts of the Wadden Sea, with largest numbers concentrated at a few sites (Rasmussen et al. 2000). During the non-breeding season numbers increase after arrival of northern breeders, which also use the area to winter (Meltofte et al. 1994). Largest numbers are present from July onwards and many birds desert the Wadden Sea between September and November. Especially in Denmark, numbers fluctuate less throughout the year compared to other parts of the Wadden Sea. Like Black-headed Gull, not all birds frequent high tide roosts and show distinct tidal movements. Many birds stay at inland sites to feed on improved grassland and arable fields, and are out of reach of the counts. Many of these birds stay in the Wadden Sea during night. Besides, offshore feeding occurs, which is also not always taken into account during high tide counts. High tide roosts are usually situated at salt marshes, with large numbers also at beaches in the Netherlands and at the Margrethe Kog in Denmark.

The distribution map shows strongholds in the Dutch and Danish sections of the Wadden Sea. About 91% of the birds stay at SPA designated sites. Largest numbers are found at Margrethe Kog, DK. Elsewhere in the Danish Wadden Sea, Common Gulls are numerous around Fanø. In the Dutch section, the islands Griend, Vlieland, Terschelling and Ameland support large roosts, as do some local sites along the mainland coast. Like Black-headed Gull, potential conflicts with anthropogenic disturbance is mainly to be expected during the breeding season. Winkelman (1992) has reported some evidence for disturbance from wind farms, with avoidance distances up to 250-500 m.

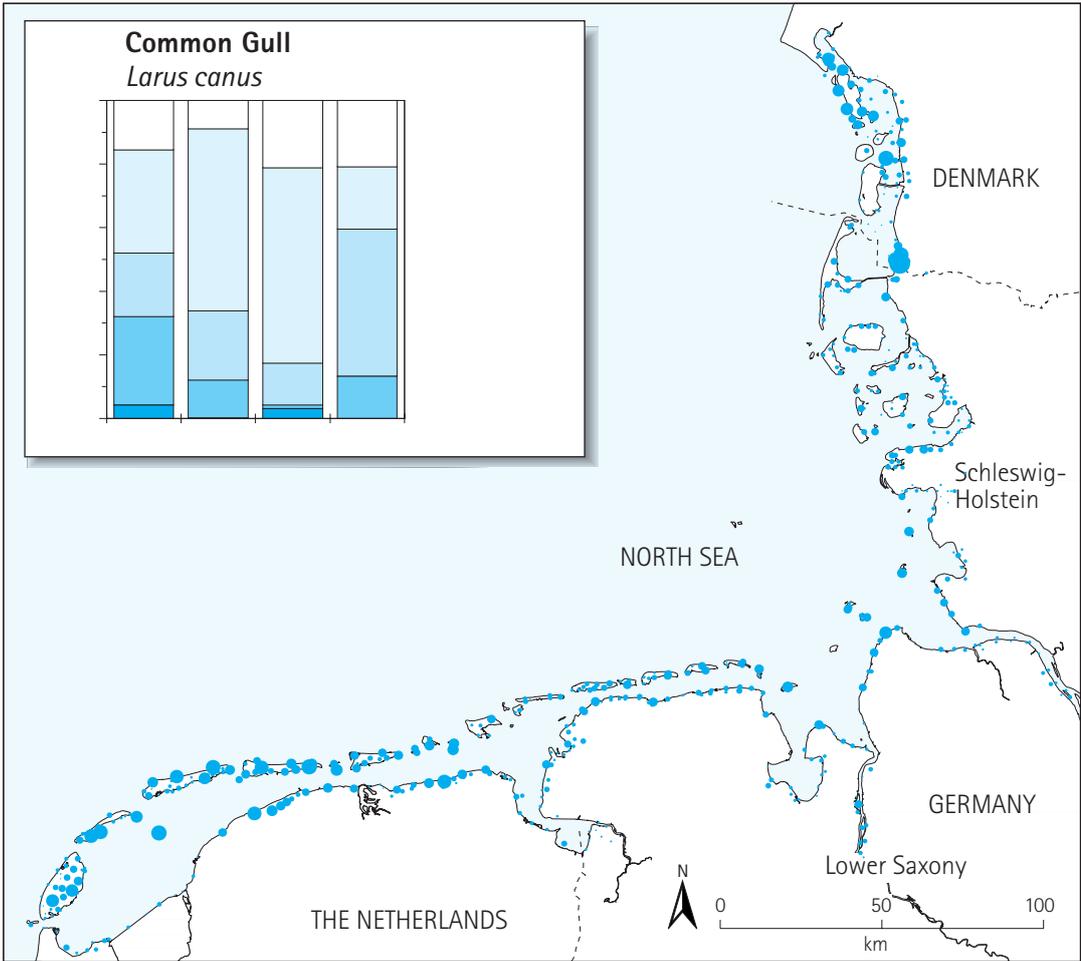


Figure 5.46: Distribution of high tide roosts (map) and habitat distribution of the high tide roosts (inset) of Common Gull in the Wadden Sea.

5.2.24 Herring Gull

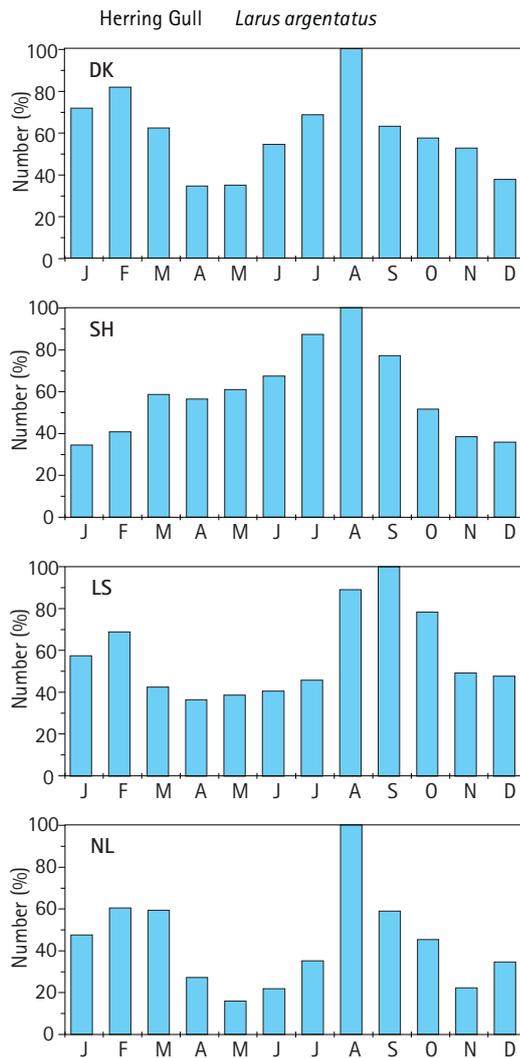
Larus argentatus

DK: Sølvmåge

D: Silbermöwe

NL: Zilvermeeuw

Figure 5.47:
Phenology of Herring Gull
at high tide roosts in
Denmark (max. 48,103),
Schleswig-Holstein
(40,476), Lower Saxony
(54,890) and the
Netherlands (143,699).



Herring Gull is a numerous breeding bird, especially at the islands in the western part of the Wadden Sea (Rasmussen et al. 2000). The species is abundant in the non-breeding season as well, representing migrants from northern Europe and local breeding populations (Meltotte et al. 1994). The seasonal pattern is not as pronounced as that of the smaller gulls. Largest numbers are generally observed in winter and early spring and in the post-breeding period from July to September. As for the other gulls, tidal movements do occur but do not involve all birds present. Many Herring Gulls also feed offshore at the North Sea and follow fish and shrimp trawlers, others stay at harbours and at rubbish dumps. Thus, only a part of the population present is covered during the waterbird counts. Where high tide roosts are used, these are mainly found at beaches and sand flats.

Herring Gulls are more or less equally distributed over the Wadden Sea, with slightly smaller numbers in Schleswig-Holstein. About 96% occur within SPA boundaries. The largest roost is Trischen SH, which also supports a large breeding colony. Elsewhere, large roosts are situated at Skallingen DK, the North Sea beach of Terschelling NL, De Groede, Terschelling and Posthuiswad Vlieland NL. Both Terschelling sites are close to the second largest breeding colony in the Wadden Sea (Boschplaat). As Herring Gulls have adapted themselves in many ways to human environments, disturbance is probably only confined to breeding sites. Some disturbance, however, has been reported around wind parks (Winkelman 1992), which are avoided up to 500 m.

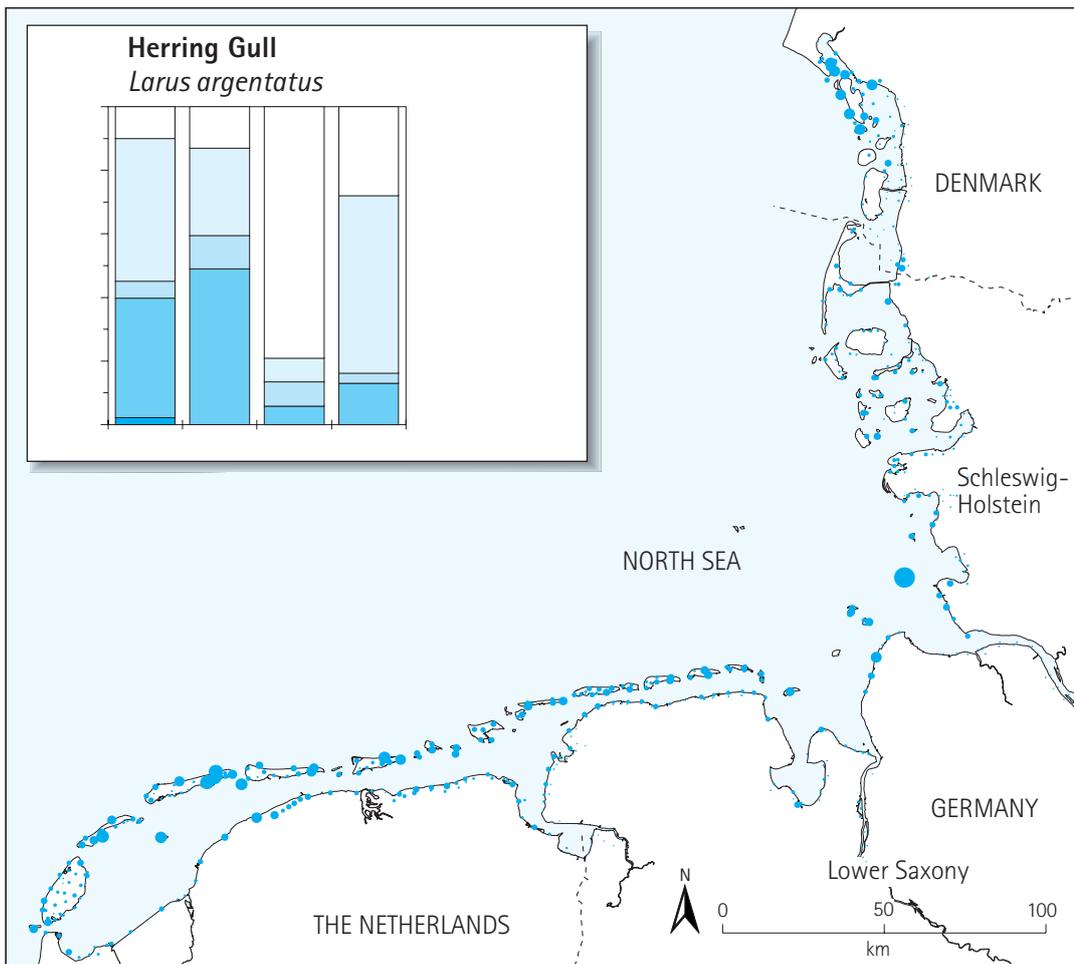
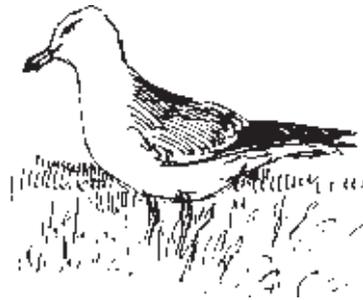


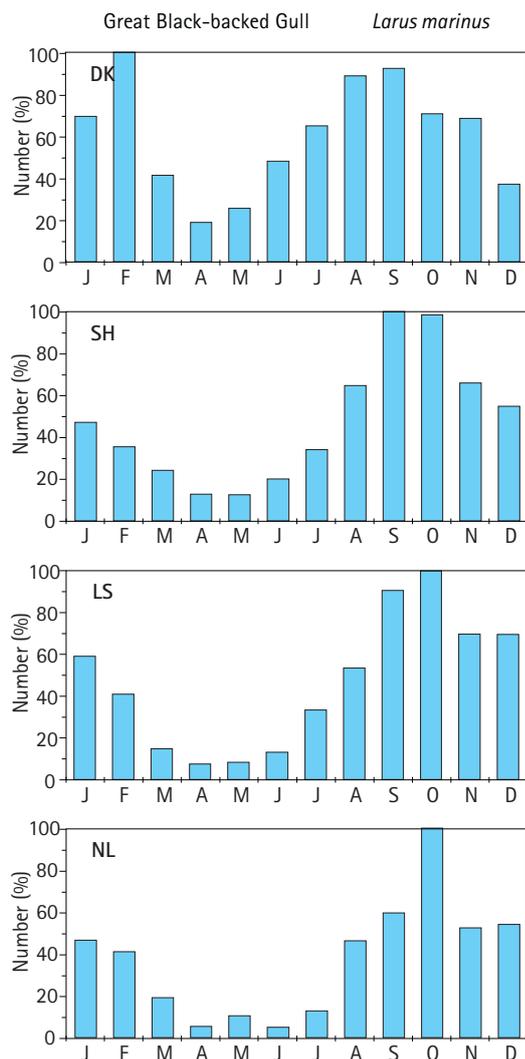
Figure 5.48: Distribution of high tide roosts (map) and habitat distribution of the high tide roosts (inset) of Herring Gull in the Wadden Sea.

5.2.25 Great Black-backed Gull

Larus marinus

DK: Svartbag D: Mantelmöwe NL: Grote Mantelmeeuw

Figure 5.49: Phenology of Great Black-backed Gull at high tide roosts in Denmark (max. 3,058), Schleswig-Holstein (2,381), Lower Saxony (2,337) and the Netherlands (13,816).



Great Black-backed Gull is a rare breeding bird in the Danish and Schleswig-Holstein parts of the Wadden Sea, and accidental elsewhere (Rasmussen et al. 2000). During winter and migration periods it is numerous, but not as abundant as other gull species (Melfo et al. 1994). Highest numbers are recorded in February (Denmark) and in September-October. In Denmark, numbers already build up in August. Great Black-backed Gulls do not always attend high tide roost, but often stay offshore as well as in harbours where they are not included in the counts. When using roosts, sand flats and beaches are favoured. Fewer birds stay at salt marshes, and some also at inland sites.

Nearly all (98%) Great Black-backed Gulls stay in SPA designated parts of the Wadden Sea. Large roosts are mainly distributed over the North Sea sides of some islands in the westernmost (Razende Bol, Texel, Vlieland, Terschelling, all NL) and northernmost (Fanø, DK) parts of the Wadden Sea. Best sites (annual mean >500) are Razende Bol, NL, and Noordsvader, Terschelling, NL. Interactions with human activities is probably low, i.e. the birds benefit from fisheries and harbour activities but are not easily disturbed.

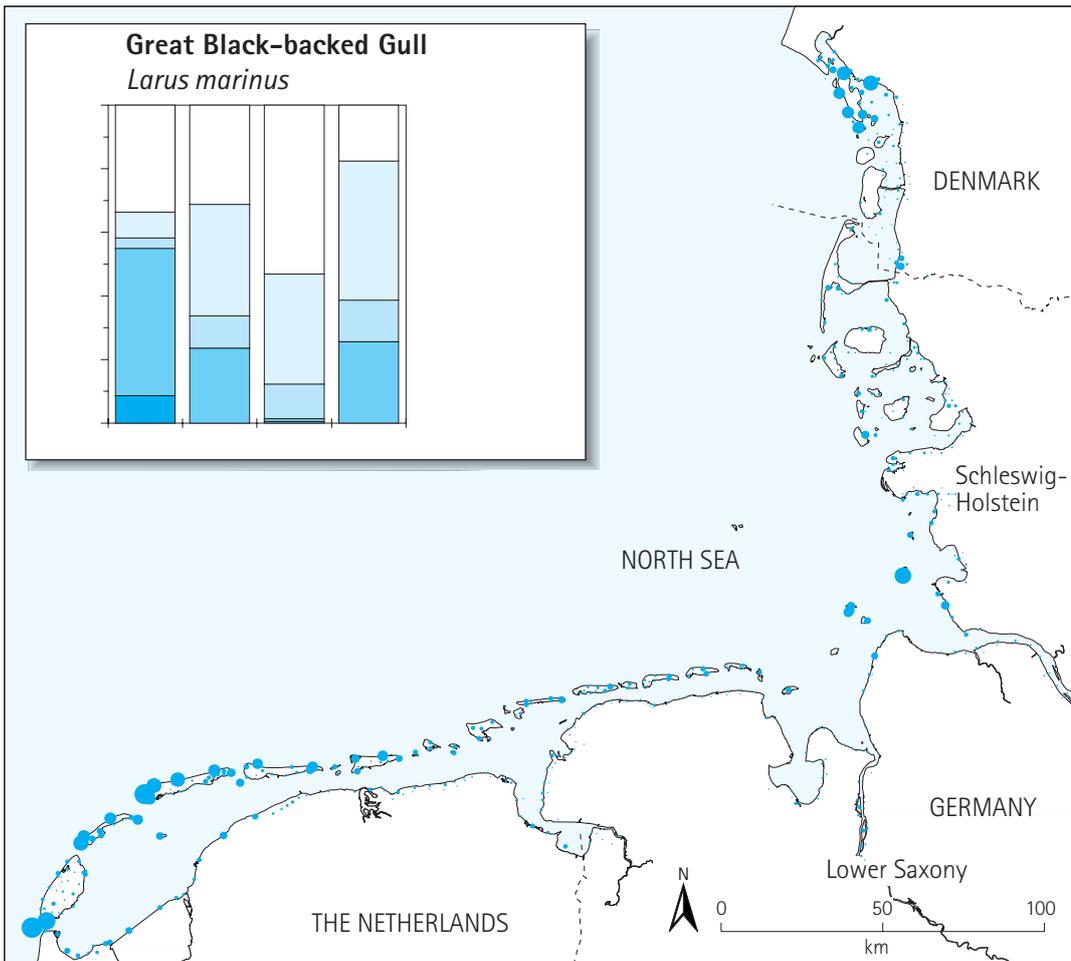
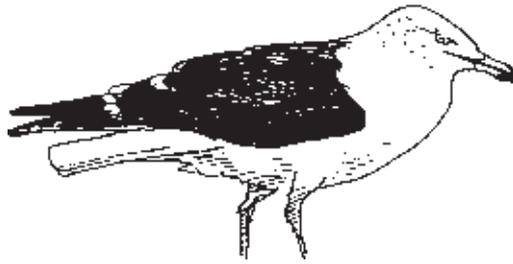


Figure 5.50: Distribution of high tide roosts (map) and habitat distribution of the high tide roosts (inset) of Great Black-backed Gull in the Wadden Sea.

6. Discussion and Conclusions

6.1 Numbers and distribution of waterbirds at high tide roosts

As part of the Wadden Sea Plan Project 34, this report presents a detailed analysis of the distribution of roosting waterbirds and the occurrence of potential anthropogenic disturbance at high tide roosts in the Wadden Sea. For this purpose, all important roosting sites within the Wadden Sea Cooperation Area have been taken into consideration. In some regions roosting sites outside the Cooperation Area were included as well. These mainly represent roosting sites behind the seawall, which belong to the network of roosting sites and are important for certain species or during exceptional weather conditions. Data on bird numbers and distribution were derived from waterbird counts which are carried out in the framework of the Joint Monitoring Program of Migratory Birds (JMMB), which is part of the Trilateral Monitoring and Assessment Program (TMAP) in the Wadden Sea. The smallest level of counting areas was assumed to give an accurate overview of roosting sites, especially since discrete roosts are often difficult to distinguish at a smaller level and usually show frequent exchange of birds during one high tide. Data on potential sources of anthropogenic disturbance were lacking for most sites and therefore mainly retrieved from experiences and expert knowledge of national experts, added with trilateral data from the latest Quality Status Report (de Jong et al. 1999) and national data from previous analyses (Knoke & Stock 1994). For the purpose of this report, a special inventory was set up to assess all important sources of anthropogenic activities at roosting sites. The results of this inventory were discussed during two meetings to calibrate the estimates between the countries.

The Wadden Sea attracts more than 10 million waterbirds from 52 geographically distinct populations of 41 species (Meltøfte et al. 1994). Except for birds which mainly stay offshore, like sea-ducks

and moulting Shelducks, many of these species depend on communal roosts during high tides, when their feeding areas become flooded. Here, they gather in large flocks, which allows them to minimise risk of predation by predators like Peregrine Falcon. Attendance of high tide roosts of individual species is a complex phenomenon and a result of suitable distance and size to/of the nearest feeding grounds in the intertidal area, lack of disturbance, actual water tables and species-specific behaviour like site-fidelity, habitat preferences and social dominance (see review in chapter 3). The species' response to these constraints is dynamic and often varies in time and space. When regarding overall distribution of high tide roosts in the Wadden Sea, highest numbers (here expressed as annual mean number of total birds, see chapter 2.3.3) concentrate at rather remote sites at islands which have hardly any public access. Examples of such sites (with annual mean in parentheses, only sites with > 20,000 individuals listed) are Keldsand/Fanø in Denmark (23,000); Süderoogsand (32,000) and Trischen (61,000) in Schleswig-Holstein; Memmert (25,000), Spiekeroog-Ost (23,000), Scharhörn (30,000) in Lower Saxony and Hamburg as well as Griend (56,000), Richel (37,000) and Vliehors/Vlieland (two sites, 24,000 and 27,000 respectively) in the Netherlands. Furthermore, a number of sites along the mainland coast support large numbers and are of outstanding importance, e.g. Margrethe Kog in Denmark (two sites, annual mean 45,000 and 34,000 birds respectively), the salt marshes of Dieksanderkoog (two sites, 20,000 and 50,000 respectively) in Schleswig-Holstein as well as Dollard (23,000), Bildtpollen (29,000) and Balgzand (25,000) in the Netherlands (Fig. 6.1). Note that the figures mentioned here only refer to annual mean numbers, maximum numbers may be considerable higher and also reach high values at other sites.

Many of the sites listed above have a central position adjacent to a large intertidal area, and

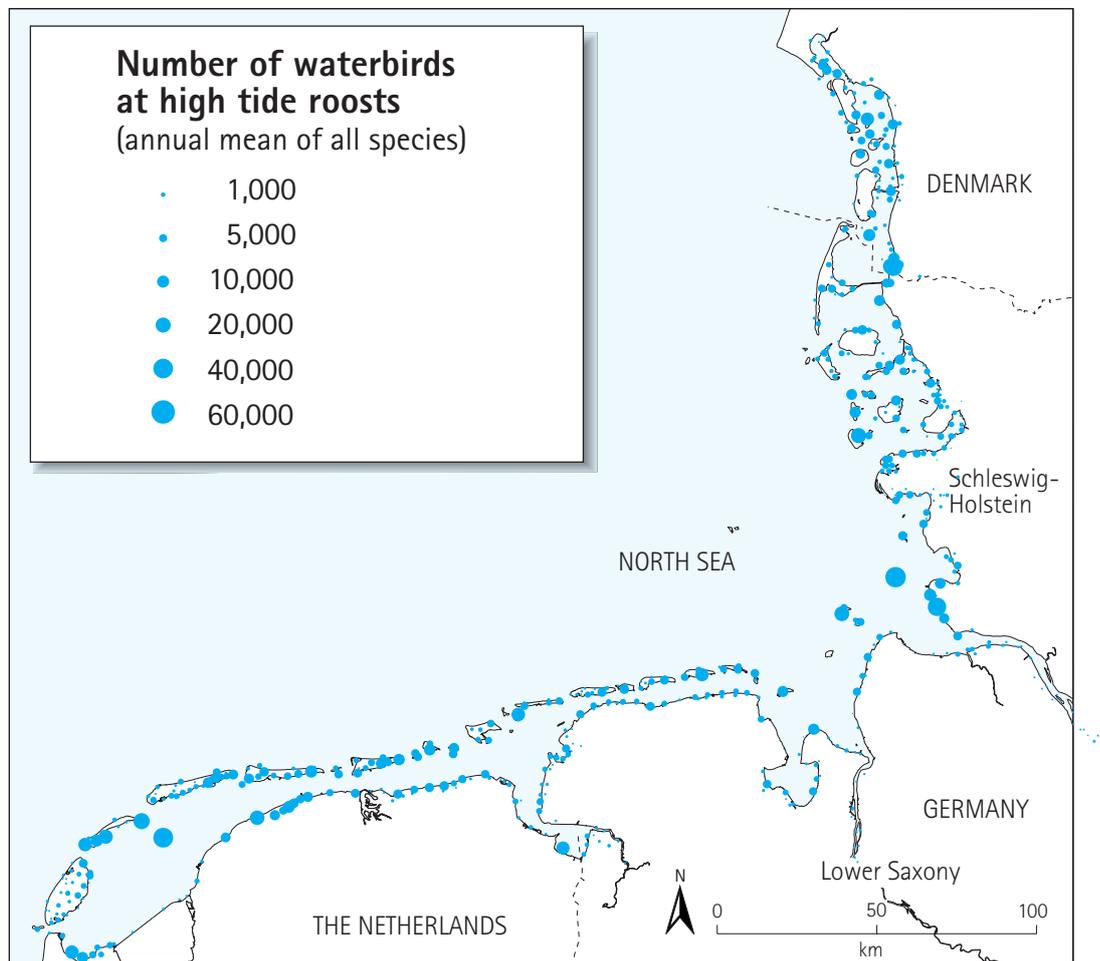
therefore are assumed to attract birds from large areas. This is true, e.g., for Süderoogsand, Trischen, Scharhörn, Memmert, Griend, Richel, Vliehors, Dieksanderkoog and Balgzand. Moreover, as mentioned before, accessibility to most of these sites is limited, so levels of anthropogenic disturbances are rather low compared to, e.g., mainland sites, which are in general better accessible and often impose a higher risk of disturbance. Therefore, it can safely be assumed that the combined effects of the absence of disturbances and large related feeding areas allow for the particular high concentrations of roosting birds found at these sites. However, some high tide roosts have remarkable numbers despite estimated moderate or high disturbance levels. The two sites at the Vliehors (Vlieland) in the Netherlands are even positioned in a military shooting range (see chapter 4.4). Birds have been reported to respond to military activities here (Koolhaas et al. 1993), but during the counts (which are carried out on weekends!) military training activities are usually absent, thus allowing large birds to roost in the area. Appar-

ently such a site is, despite its supposed impact from military activities, still a favoured roosting site, probably also because recreational activities are generally low at the Vliehors most of the year and a large area of mudflats is available in the adjacent intertidal area during low tide. It would, however, be useful to study attendance of roosting sites in more detail here, in order to assess the direct impact of military training activities more detailed.

6.2 Protection regimes

The outstanding importance of the Wadden Sea has been acknowledged in several international conventions and directives, such as the Ramsar Convention, the Bonn Convention on Migratory Species and the EC Bird and Habitat Directives, which have been implemented in the national legislation and the respective protection regimes. These include mainly national parks and nature and wildlife reserves. Other designations such as Special Protection Areas (SPAs) and Ramsar sites,

Figure 6.1: Distribution of waterbirds at high tide roosts in the Wadden Sea. Shown is the sum of annual means for all species listed in Table 2.2, chapter 2.3.2).



according to the EC Bird Directive and Ramsar Convention respectively, overlap largely with these national protection regimes (see chapter 4.3 for a review). Most bird species in the Wadden Sea occur within the boundaries of protected areas. However, some species often concentrate outside protected areas. This holds true especially for Golden Plover (88% in protected sites), Turnstone (87%) and Brent Goose (79%). As shown in figure 3.2 (chapter 3.3), these species often occur in anthropogenic habitats like breakwaters and other rocky habitats in, e.g., harbours and along dikes (Turnstone), or in improved grasslands and crops in inland areas (Golden Plover, Brent Goose). Such areas often are not included in any protection regime since they do not refer to wetlands but mainly represent agricultural areas. Moreover, they are mainly positioned outside the Wadden Sea Conservation area, although belonging to the network of roosting sites.

When comparing protection regimes between countries, Denmark and Schleswig-Holstein have the highest proportion of high tide roosts being protected, followed by Lower Saxony and the Netherlands (see chapter 4.3). However, the latter two countries have a larger proportion of (unprotected) inland sites among their roosting sites, which frustrates a direct comparison with Schleswig-Holstein and Denmark. In Lower Saxony, the most important inland sites, which support not only high tide roosts, but also large numbers of other migratory waterbirds (see Melter & Schreiber 2000) have been designated as SPAs. In the Netherlands, on the other hand, such areas have been excluded in the latest update of SPAs in 2000 (see van Roomen et al. 2000), although they support important numbers as well, involving both high tide roosts as well as several other waterbird species like swans and geese and rare breeding birds (Engelmoer & Altenburg 1999, van Roomen et al. 2000).

6.3 Potential sources of anthropogenic disturbance

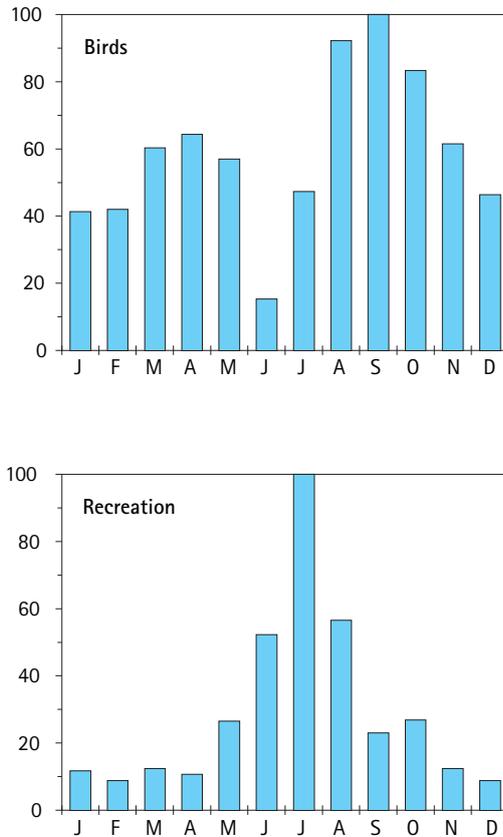
It is well known that the number of birds attending a high tide roost is often closely associated with the level of human disturbances (e.g. Davidson & Rothwell 1993a, Cayford 1993, Knoke & Stock 1994). In the Wadden Sea, this has been confirmed by numerous case studies (see chapter 3.4.2 for a review). Recreational activities are by far the most important source of potential disturbance at high tide roosts in the Wadden Sea. These may have a pronounced impact on the distribu-

tion and numbers of roosting birds at many sites (see chapter 3.4.2 and 4.4). At a smaller temporal or spatial scale, hunting, military training, civil aviation and wind farms may affect numbers at roosting sites as well (see chapter 3.4.2 and 6.1). Among these, hunting may have the highest impact, since it causes direct mortality as well as a higher susceptibility of birds to other kinds of human disturbance (Frikke & Laursen 1994, Madsen 1995, Madsen & Fox 1995). Farming, on the other hand, which also occurs at many sites, is thought to have a minor impact as far as direct disturbance to roosting birds is considered.

Many of these human activities are supposed to be currently managed by trilaterally agreed policies and their subsequent national implementation (Ministerial Declarations 1991, 1994, 1997, 2001, Wadden Sea Plan 1997, de Jong et al. 1999). These include regulation of recreational developments, hunting legislation, military training activities, gas and oil exploitation, wind farms and civil aviation. However, hunting regulations in many cases only involve hunting on migratory waterbirds, which has been largely restricted or prohibited in most countries now, though many of these regulations came into force during the time period where the field data for this report were collected. Besides limited hunting on waterbirds, hunting on small mammals like Hare and Rabbit is still common practise in many salt marsh areas, at inland roosting sites and on the islands in the entire Wadden Sea. Although data on the scale and the direct impact of this kind of hunting on bird numbers at roosting sites are not available, they may cause a considerable disturbance, especially when carried out in close vicinity of high tide roosts, where any shooting can easily disturb the large roosting flocks.

Recreational activities like hiking, leisure boating, certain sports or just spending summer days dispersed along salt marsh edges are by far the most observed sources of disturbance for roosting birds on terrestrial sites in the Wadden Sea (see review see chapter 4.4). To some extent these are regulated, e.g., by establishment of visitor information and guiding systems as well as by spatial and temporal zoning within the protected areas (Wadden Sea Plan 1997, de Jong et al. 1999, for national examples see also Knoke & Stock 1994 and Stock et al. 1996). When comparing the general phenology of bird numbers in the Wadden Sea, it becomes obvious that most potential conflicts between roosting birds and outdoor recreation occur in late spring (May) and late summer (especially July-October; Fig. 6.2), when both the in-

Figure 6.2: Comparison of phenology of bird numbers in the Wadden Sea (based on data from this report) and occurrence of recreational activities outside beach resorts (after Laursen et al. 1997).



tensity of recreational activities and the numbers of migrating and staging birds are high. For migratory birds, this part of the year is critical since, being long-distance migrants which breed in the Arctic and winter in Africa (e.g. Red Knot, Bar-tailed Godwit), these species have to accumulate body reserves for migration and breeding during this time of the year (Meltofte et al. 1994). Moreover, many waterbirds gather to moult in the Wadden Sea in late summer and are highly vulnerable during this part of their annual life-cycle.

Local observations have several times pointed out the impact of recreational activities regarding attendance of roosting sites. Kersten et al. (1987) and Südbeck (1999) showed distinct phenology patterns for Curlew between neighbouring roosting sites at Ameland and the mainland coast of Friesland, the Netherlands, and between Spiekeroog and Wangerooge, Lower Saxony. Here, Curlew avoided roosting sites with high numbers of visitors or the most visited time of the day. The same pattern also seems to occur when compar-

ing phenology patterns in the entire Wadden Sea, according to the different estimates for recreational activities (Fig. 6.3). At roosting sites with estimated moderate or heavy recreational pressure, numbers in late summer built up especially from August-September onwards, compared to July-August at sites with low or no recreational activities. This pattern suggests an avoidance of crowded areas. A similar phenology pattern is even shown by Oystercatcher, a species which many consider as rather robust against human disturbances. These results are in line with the case studies mentioned before and confirm the findings of Laursen et al. (1997), who used simultaneous collected data on bird distribution and numbers of visitors in the Danish Wadden Sea, and showed a negative relationship between the numbers of some duck, wader and gull species and the number of visitors in spring and autumn, i.e. in the period with highest potential conflicts between bird numbers and recreational activities.

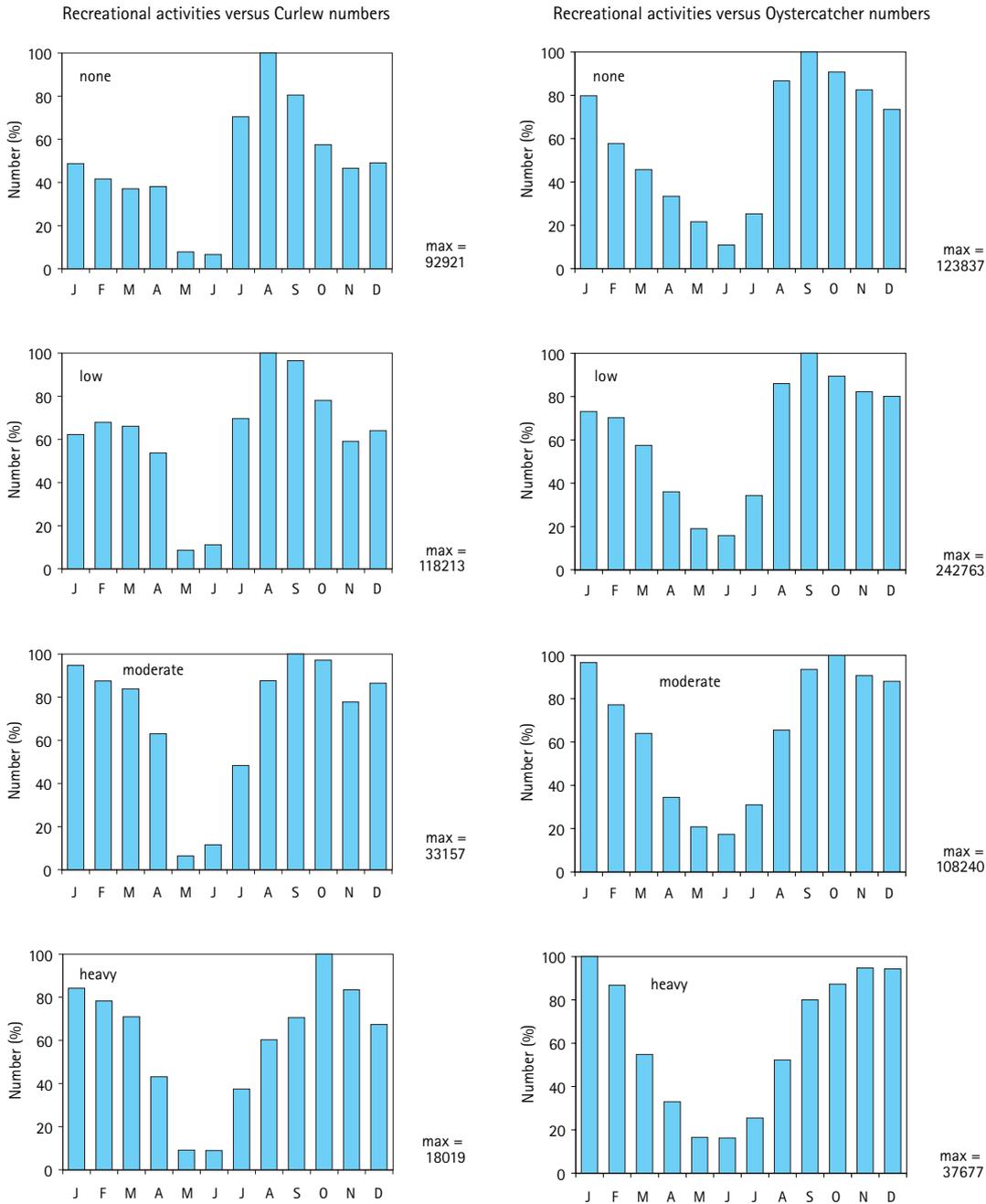
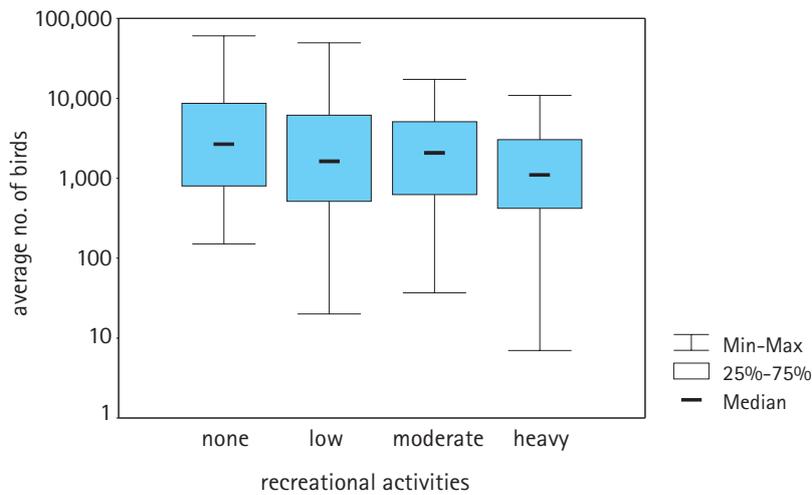


Figure 6.3: Phenology of Curlew and Oystercatcher in the Wadden Sea according to different levels of estimated recreational activities.

Figure 6.4:
 Total numbers of birds at high tide roosts according to different levels of estimated recreational activities. The difference is significant (Kruskal-Wallis Anova, $H = 13.9$, $p=0.003$), note however, variation is large.



We have also compared the total numbers of birds for each site in our data with the estimated intensity of recreational activities (Fig. 6.4). Numbers at roosting sites with no or only low recreational activities have significantly larger numbers compared to roosting sites with assumed moderate to heavy recreational activities (Kruskal-Wallis ANOVA, $H = 13.9$, $p = 0.003$). However, variation is large and several factors might operate independently from each other. Moreover, roosting sites, which support large numbers of birds, will also have a higher chance to experience some management measures with the aim to reduce human disturbance. This in turn would automatically lead to larger numbers at these sites. Therefore, it will be very difficult to prove to what extent roosting sites in the Wadden Sea are affected by disturbances without carefully designed experiments.

6.4 Conclusions and recommendations

Waterbirds in the Wadden Sea are faced with a large number of constraints. They depend on limited food resources, competition with other species and narrow migration schedules and have to cope with the risk of predation. Human activities can easily put an extra constraint on the birds' annual life cycle since the time they fly around after disturbance will increase energy expenditure which needs to be compensated for. Susceptibility to human activities is merely a result of negative experiences birds had with human activities, especially hunting. It is well known that species which are hunted are highly susceptible to other sources of human disturbance and show adaptive behaviour like larger flight distances.

As the guiding principle for the Wadden Sea policy is to „achieve, as far as possible, a natural and sustainable ecosystem in which natural processes proceed in an undisturbed way“ (Ministerial Declaration Esbjerg 1991), it becomes clear that the non-natural causes for disturbance effects must be reduced as much as possible. This is also well reflected in three of the four trilaterally agreed targets on birds in the Wadden Sea Plan (1997), which require „natural breeding success“, „sufficiently large undisturbed roosting and moulting areas“ and „natural flight distances“. These targets very well reflect the major importance the Wadden Sea has for the large numbers and in some cases even entire populations of migratory waterbirds. Since most birds depend on high tide roosts and gather in large concentrations which are highly susceptible to any kind of disturbance, safeguarding of high tide roosts is an important tool to achieve these goals.

With this report, a detailed overview of high tide roosting sites has become available, along with a review of protection regimes, potential an-

thropogenic disturbance and a detailed description of species. Since major parts of the Wadden Sea have been designated as protected areas, the formal protection for most of the high tide roosts seems to be sufficient. However, this does not hold true for a number of inland roosting sites, which are important for some species (e.g. Brent Goose, Golden Plover, Curlew) or as alternative roosting sites during periods with high water tables. Especially in the Netherlands, such sites often lack any protection regime, although they support roosts as well as large numbers of other migratory bird species (Engelmoer & Altenburg 1999, van Roomen et al. 2000).

Recreation

Concerning potential anthropogenic disturbance, our data show that despite their formal protection, most of the high tide roosts in the Wadden Sea are subject to some kind of recreational pressure. Although some of the important roosting sites are well protected, our data on phenology as well as previous case studies carried out in various parts of the Wadden Sea point at a negative impact of moderate to heavy recreational activities on the number of birds attending high tide roosts, especially in spring and in late summer (see chapter 6.3). The volume of recreational activities is supposed to grow further in future years and tends to expand to other parts of the year as well (de Jong et al. 1999). Conflicts between tourism and nature conservation will probably increase in future, but detailed knowledge of flight distances of waterbird species is currently insufficient, and more information is necessary when planning public access to areas in the vicinity of roosting sites with high numbers of birds. Spatial and temporal zoning of recreational activities, combined with a

convincing visitor information, is an important tool to manage the recreational activities as well and must be further developed. Also, we recommend more local studies and well-designed experiments to assess the complex relationships between occurrence and behaviour of birds at high tide roosts and recreational activities, so feedback can be given to possible management measures. With the overall guiding principle and ecological targets for the Wadden Sea in mind, it should be possible to find local solutions, where it is necessary, to reduce recreational disturbances at high tide roosts.

Hunting

At a smaller scale, also hunting probably still affects roosting numbers of waterbirds in the Wadden Sea. Especially hunting on mammals (Hare and Rabbit) is carried out in many areas throughout the Wadden Sea, both at inland roosting sites and salt marshes, but hitherto has not been included in trilateral policies concerning hunting regulations. Since these hunting activities do occur in areas close to high tide roosts (mainly salt marshes), where they might cause considerable disturbance among roosting birds, management of hunting activities should preferably be expanded to this kind of hunting as well and aim to reduce impact at least during high tide.

Other Human Activities

Military training areas, civil aviation and wind farms also influence high tide roost, but at a smaller scale than recreational activities. However, the latter two could gain importance in the future. The most pronounced conflict between military training and bird numbers occur at the Dutch island of Vlieland, where large numbers roost at the Vliehors shooting range. Roosting numbers here belong to the largest in the entire Wadden Sea, but higher numbers may well use the site when military activities would be absent, and it is recommended to study the relation of military activities and attendance of the roosts in more detail. Standards for civil aviation have been set by trilateral policies and their national implementation (de Jong et al. 1999). However, severe disturbances are reported for some areas and it is recommended to assess the impact of civil air traffic there (the same applies to ultra-light aircraft and flight routes of military aircraft). The impact of wind farms should be studied in more detail, especially for other species than geese. Though already forbidden in the Wadden Sea Conservation Area, the set up of wind farms in the immediate surroundings should be more carefully selected in future, by avoiding inland concentrations of roosting birds and keeping an appropriate distance to any salt marsh and high tide roost.

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